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THE ELECTRICAL REVIEW

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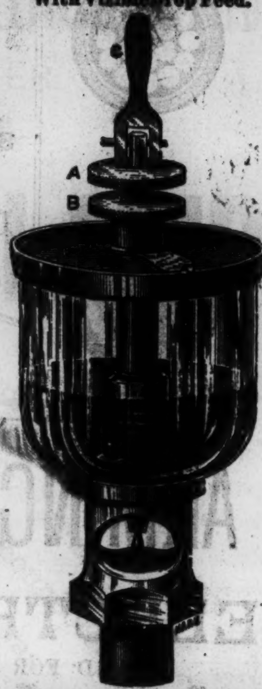

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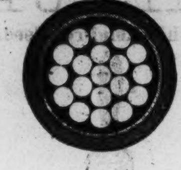

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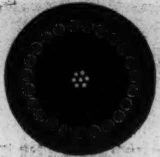

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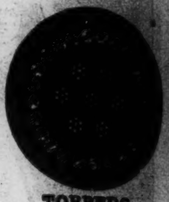

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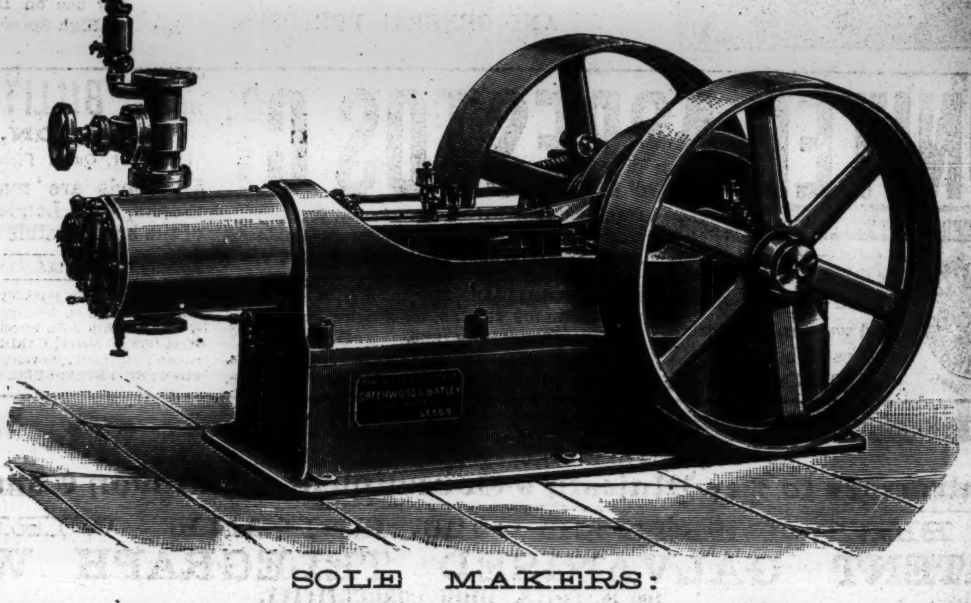

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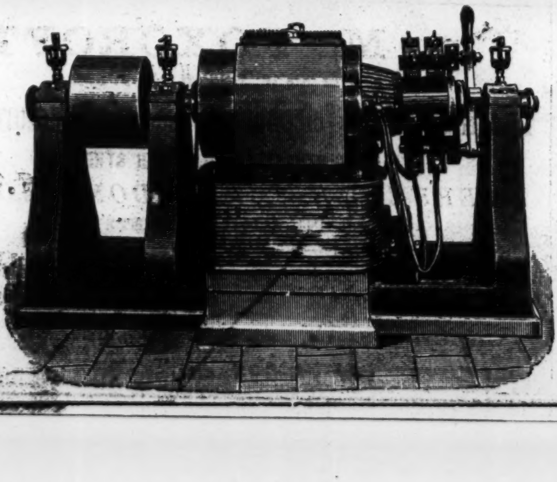

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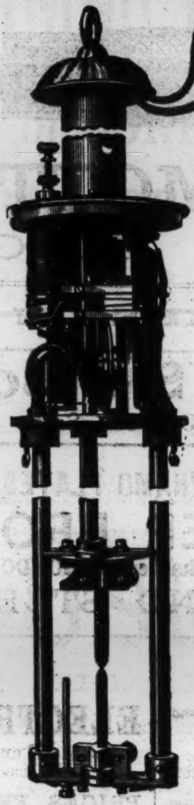

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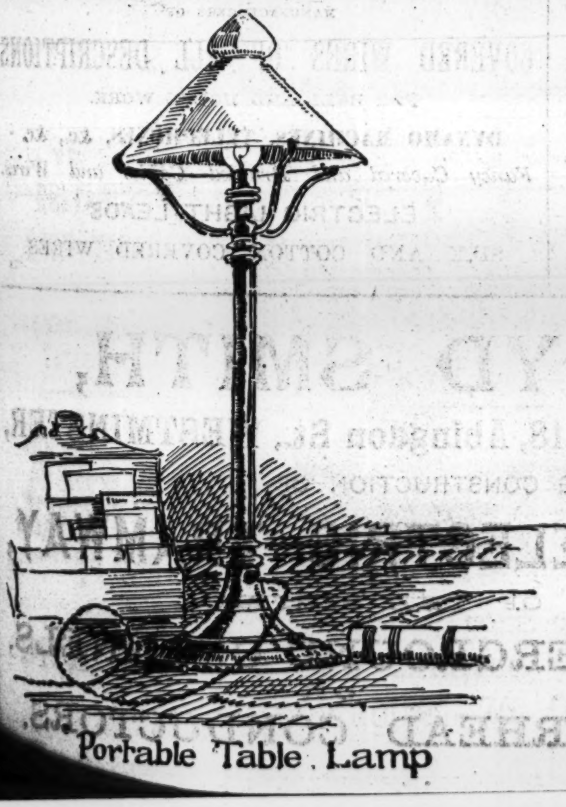

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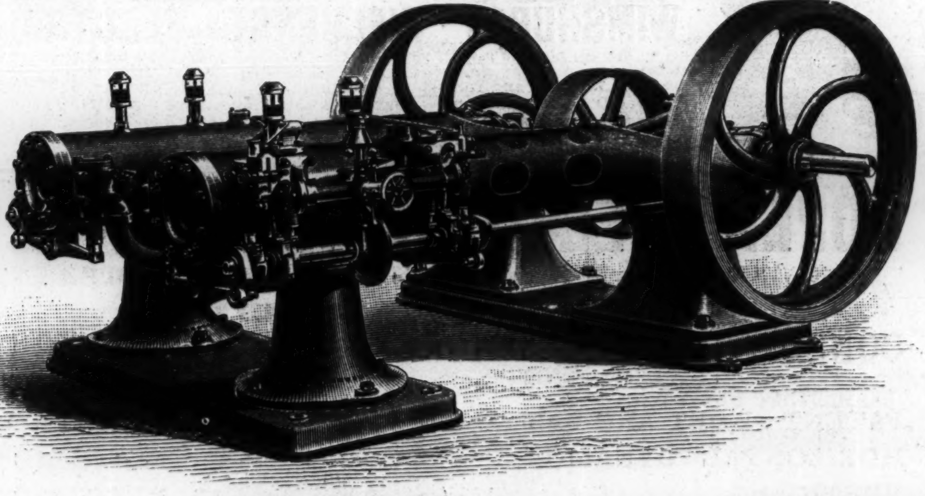

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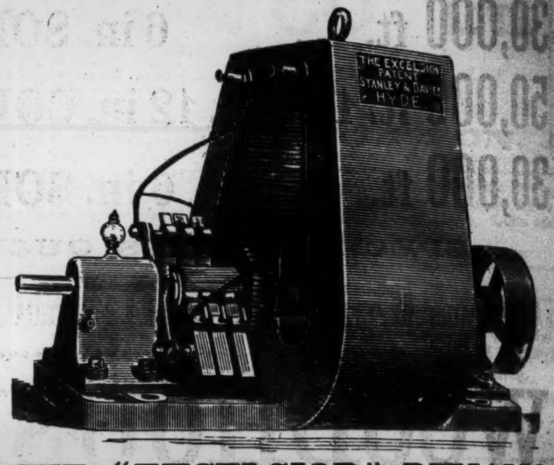
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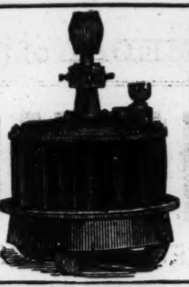

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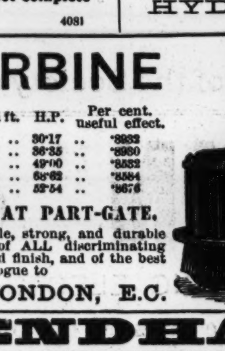
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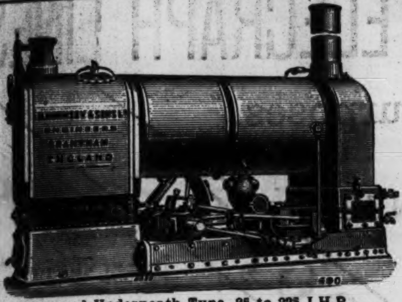

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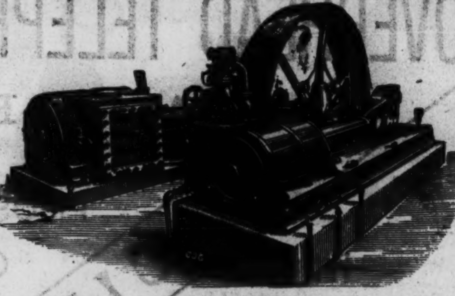

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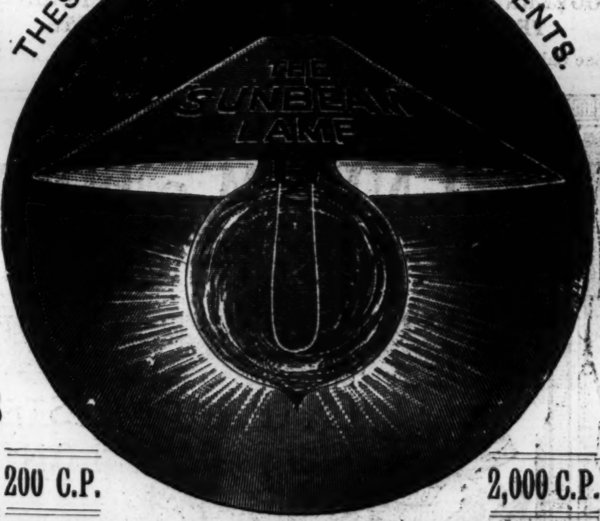

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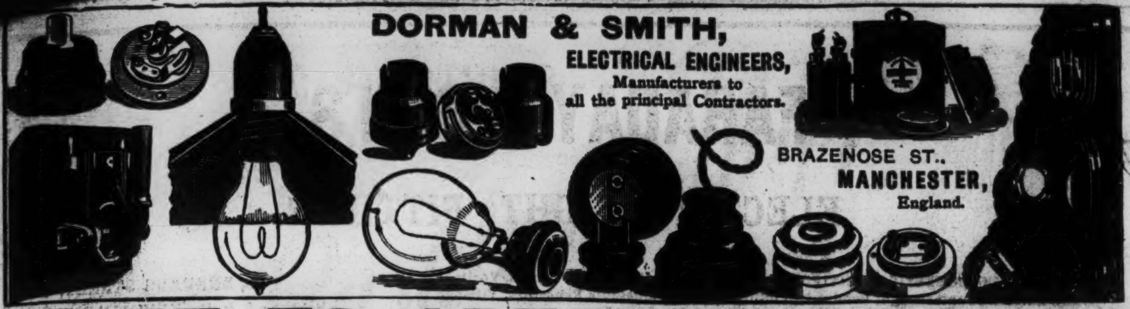

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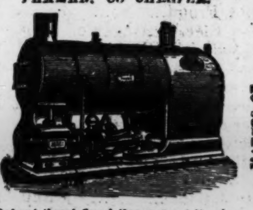

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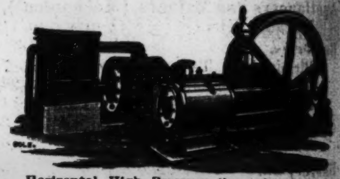

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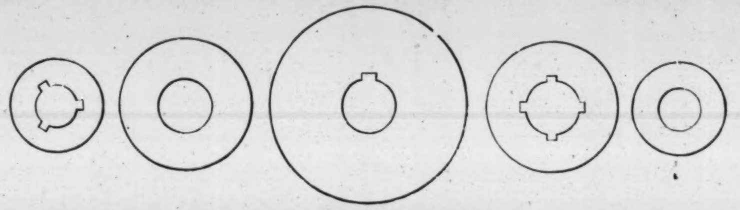

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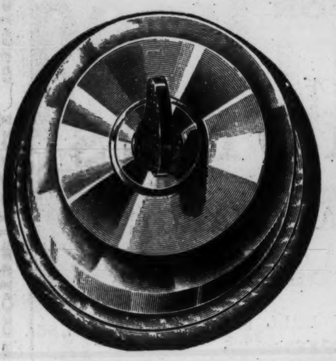

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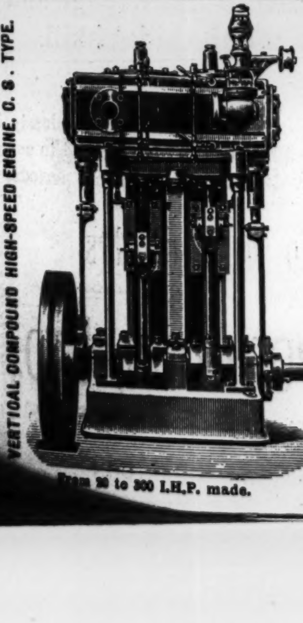

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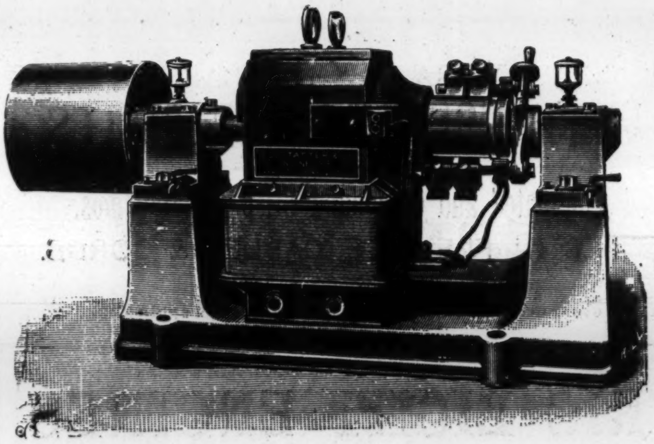

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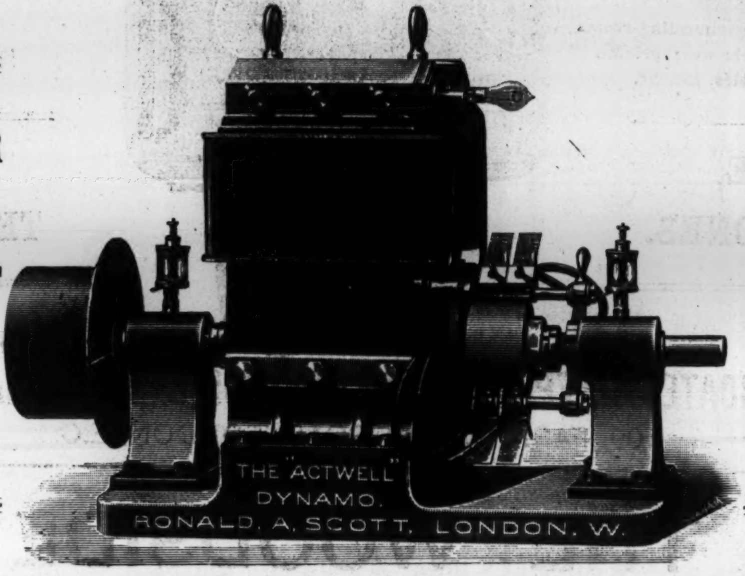
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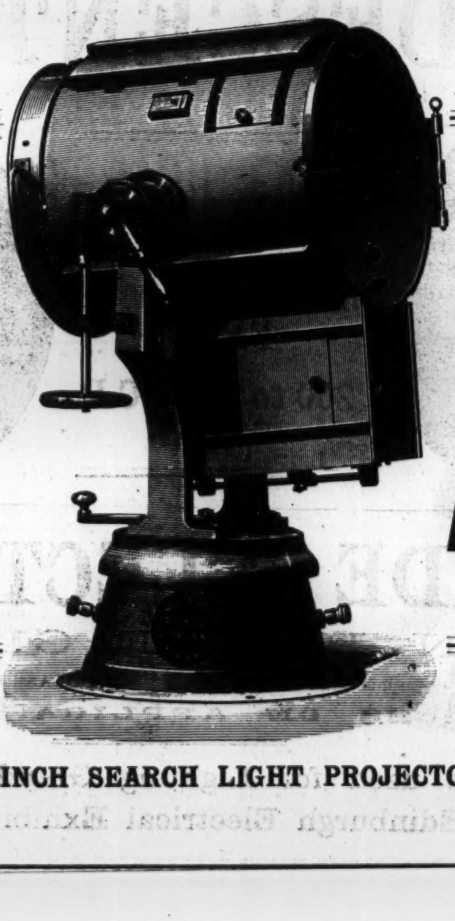

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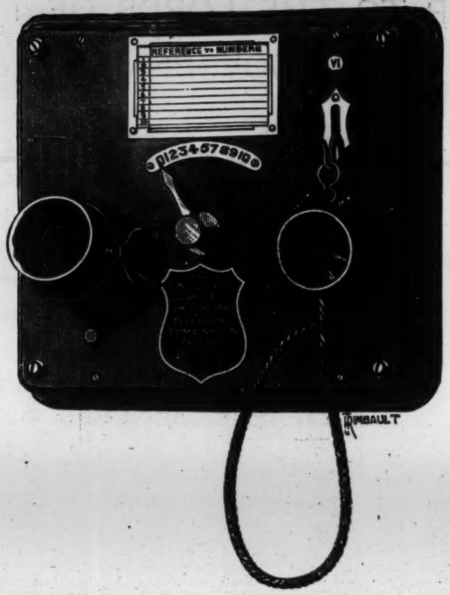

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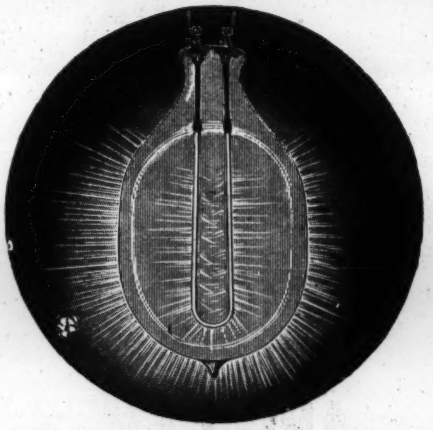

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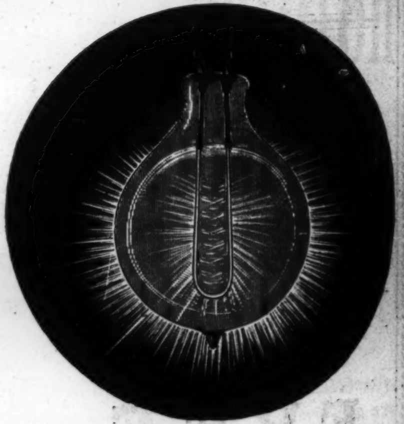

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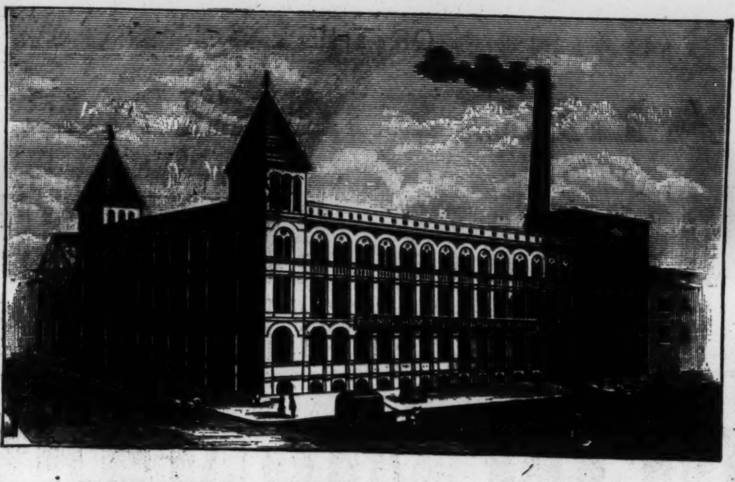

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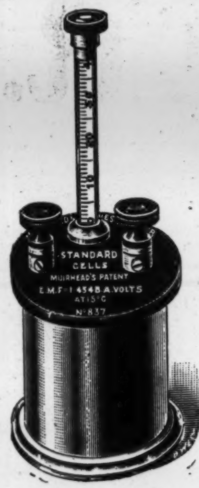

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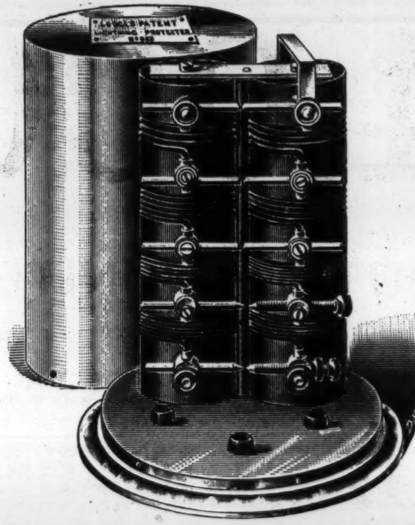

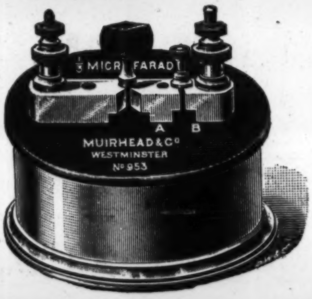

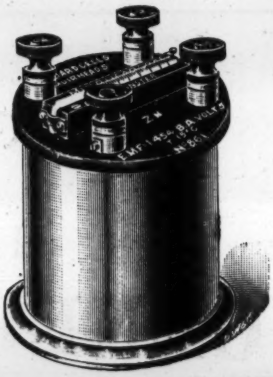

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ELECTRICAL REVIEW.

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OVERHEAD ELECTRIC LIGHT WIRES.

The difficulty which has arisen between the Board of Trade and various electric light contractors, with reference to certain of the regulations for overhead lines prescribed by the former, still continues; and at present there appears to be no prospect of a satisfactory agreement being arranged. A memorandum has been issued by the London Chamber of Commerce, which gives a brief history of the attempt that has been made to get a modification of the regulations respecting suspension wires and thickness of insulation; and a perusal of the correspondence which has passed between the two parties concerned, and which deals mostly with the question of thickness of insulation, has certainly not increased our appreciation of the advantages of State control. Although we have dealt with this subject on one or two previous occasions, we consider that the autocratic behaviour of the technical adviser to the Board calls for further comment, as, so far as we are aware, his experience of practical work cannot be of such an extensive character as to justify the position taken up by him, a position from which he cannot apparently be moved, even by the evidence of tests made by himself when the results of these tests do not agree with his preconceived notions.

It appears from this memorandum that the prohibitory nature of some of the Board of Trade regulations was not discovered until the latter end of 1889, when certain contractors, who were engaged at the time in carrying out public lighting, found that the thickness of dielectric required by the Board of Trade was greatly in excess of that used by manufacturers who had had considerable experience with high-pressure cables. Messrs. Crompton, one of the firms concerned, then wrote to the Board of Trade enclosing a sample of a wire covered with vulcanised rubber to a thickness which gave an insulation resistance of 5,000 megohms per mile, this wire being what they proposed to use at Chelmsford. In reply, they received a letter from Major Cardew saying that the wire did not comply with the regulations, and suggesting that the question of these small overhead wires should be officially raised. In this same letter Major Cardew volunteers the statement that he would be greatly astonished if the sample submitted could be shown to have an insulation resistance of 5,000 megohms per mile after immersion in water for twelve hours with 100 volts applied. The memorandum does not say whether he had the opportunity of being greatly astonished or not; but if the test was made (and Messrs. Crompton offered in a subsequent letter to submit the wire to this test), Major Cardew probably learnt something about the insulating qualities of good rubber, since we understand that the wire was a Silvertown class L, guaranteed to give the insulation resistance stated. In a subsequent letter, Major Cardew again declined to pass the wire, a sample of which had been submitted, and said that before he could agree to modify the rules, he would require to see the following test performed, viz., the wire to be charged to 2,000 volts alternating with one pole of the dynamo connected to earth, and the experimenter to make a thoroughly good earth himself while grasping the wire.

Some further correspondence passed, and then on March 17th the Board of Trade wrote asking for tests to be made, and enclosed with this letter a copy of a report from Major Cardew, to which we shall refer later. In May three lengths of cable were tested by Major Cardew in the presence of representatives of the several firms interested. One of these cables was insulated as per the sample submitted by Messrs. Crompton, another was insulated in accordance with the Board of Trade regulations, whilst the third was insulated to a thickness intermediate between those of the first and second. All these cables successfully passed the tests imposed by Major Cardew, and the firms represented at the trials naturally thought they were on the high road to getting the obnoxious regulation amended; but to their surprise a letter was received from the Board of Trade, saying "the tests referred to in their letter of 17th March having been made, they are not prepared to sanction any reduction of the thickness of insulation prescribed in their regulations." Memorials were then sent to the Board of Trade by the London Chamber of Commerce, and by the firms whose representatives had witnessed the tests, and in the latter the satisfactory nature of the trials was referred to, and an amendment to the regulation was proposed, which suggested as a compromise that the minimum thickness should be $\frac{1}{16}$-inch for 2,000 volts, and that the cables should have an insulation resistance of not less than 1 megohm per mile per volt when tested in water at 60° Fahr. after immersion of at least 60 consecutive hours. To these memorials replies were received stating that the Board of Trade were not prepared to modify their regulations.

We have carefully read through the various letters from the Board of Trade, as reproduced in the memorandum, with a view to finding out the ground on which they base their refusal to modify the regulations; and so far as we can judge it appears to be this:—The Board of Trade have made certain regulations, concerning which "they consulted the council of the Institution of Electrical Engineers, whose members possess the highest scientific attainments, and have also large practical acquaintance with the working of electric light undertakings;" the council adopted these regulations, therefore they must be right, and the Board of Trade will not alter them. Now the question arises as to which party has had most practical experience, the committee of two years ago, which was mainly composed of scientists not personally engaged either in the manufacture or erection of electric light cables, or the manufacturers and contractors who are to-day asking that the rules should be modified? The Board of Trade appears to think that the former are the men of experience, but perhaps they have learnt something since they adopted these regulations, so that it might be advisable to get a fresh opinion from them on this subject. It is possible, however, that the adoption of the regulations by the council of the Institution is only a convenient excuse, and that the real stumbling block in the way of reform is the technical adviser; and we have therefore read carefully his report, to see if we could find therein any sufficient reasons for the position of "*non possumus*" which is taken up by the Board of Trade.

In this report we find that he says that the rule should not be modified except after most careful consideration and the clearest evidence that the relaxation is necessary to prevent undue hampering of the industry, and that no appreciable increase of risk will result to the public. He further says that it has been arranged to make some lengths of cable insulated to different thicknesses, in order that he may have the opportunity of thoroughly testing their behaviour under high alternating pressures, and that these tests are likely to give valuable information. With regard to the hampering of the industry, we have the evidence of the contractors actually engaged in the work of fixing overhead lines, the evidence of the actual costs of the several types of cable made for the tests, and the opinion of the Electrical Section of the London Chamber of Commerce (expressed in a resolution passed after discussion of the whole question) that the continuance of the regulation would be seriously detrimental to the interests of the electrical trade. On the question of risk, we have the evidence of the tests made by Major Cardew. Now it will be remembered that he proposed to make these tests, arranged with a manufacturing firm for cables to be made for this purpose, and expected to get very valuable information from the results; and yet, after all these cables had satisfactorily passed his tests, the next communication from the Board of Trade simply states that the tests having been made, they cannot sanction any reduction of thickness. The reason for this peculiar decision is given in the letter replying to the memorial forwarded by those firms who had been represented at the tests, and is as follows:—These tests were applied to perfectly new cables insulated with the best quality of India-rubber, and although the result showed that under such circumstances the cables could be safely handled, the tests cannot be accepted as a sufficient guarantee of the safety of a similar thickness of this or other insulating materials after exposure for some years to wear and tear and atmospheric action. Now, if a test on new cables was to be considered as of no value, why did Major Cardew propose such a test, and arrange that cables should be made for the purpose; and how is it that in his report he speaks of these tests as likely to give valuable results? It almost looks as if he had again been surprised at the satisfactory results of the tests, and had therefore been obliged to shift his ground in his effort to hold an untenable position. The question, as we understand it, at the time the tests were made was this:—Can Messrs. Crompton use with safety a certain cable, a sample of which had been submitted to, but rejected by, the Board of Trade? Now, a cable of this class satisfied all the tests imposed by Major Cardew at Chelmsford; why, therefore, refuse to allow this cable to be used because possibly other cables which have not yet been tested would require a greater thickness of insulating material? Surely such a procedure is as absurd as it would be to specify that the steel or iron girders of a railway bridge should have the same sectional area as would be required if wooden beams were used. Then with regard to the newness of the cables, it is not usual in other branches of engineering to insist that any apparatus should be tested after it has been in use for some years before allowing it to be used at all; we find, instead, that the apparatus is tested with a greater strain than that to which it will be subjected in ordinary work; and this course is open to Major Cardew, as a clause may be inserted by him to the effect that every cable shall be subjected, when immersed in water, to a pressure, say, 50 per cent. higher than that at which it is to be used.

The report next expounds the law of insulation resistance of a cable (which, by the bye, is given inaccurately), in order to show the advantage gained in this respect by the use of a greater thickness of dielectric; but this is evidently not the reason for specifying one-tenth of an inch, as Major Cardew afterwards says that 5 megohms per mile is as good as 5,000, provided that this resistance is uniform throughout, and that the material possesses certain other qualities named by him. Major Cardew then refers to the necessity of a high resistance to disruptive discharge, and states that the sparking distance in air of a pressure of 2,000 volts alternating is $\frac{1}{16}$th of an inch, and that he considers that the minimum thickness of good insulating material should exceed this sparking distance. At any rate he wants good evidence that a disruptive discharge is not possible with the thickness and material used.

On this point there is the evidence of cables which have been in use in London and elsewhere, and have been successfully worked with a pressure of 2,000 volts, although the thickness of dielectric has been less than $\frac{1}{10}$th of an inch. There is also the evidence of the tests made by Major Cardew, which showed that a cable, covered to a thickness of $\frac{1}{25}$th of an inch only, did not break down under a pressure of 2,000 volts. Of the former evidence Major Cardew may be in ignorance, but he can hardly plead such an excuse with regard to his own tests, and yet they do not appear to carry any weight with them, or help him to come to a rational conclusion.

There is one more item in this report to which we think attention should be drawn, as it indicates pretty clearly the lines on which Major Cardew is prepared to deal with questions such as the one now under discussion. He suggests that makers and users of cable shall try to discover an insulation which shall be efficient and durable, but less expensive than the best quality of rubber necessarily must be. Surely Major Cardew cannot be ignorant of the fact that this question has been receiving an enormous amount of attention for some years past, and that therefore his suggestion is rather behind the times. But whether this is so or not, let us see what this suggestion means; does it not say in effect something like this? I, as technical adviser to the Board of Trade, have fixed on a tenth of an inch as the thickness of dielectric to be used; if your experience has shown you any insulating materials where this thickness is unnecessary, and which are too costly if used according to my specification, put them on one side, and look out for some material which is just bad enough to require the thickness I have fixed on, and cheap enough to allow of that thickness being used without the cost becoming prohibitory.

With regard to the other question, viz., the use of suspending wires, we have nothing to add to our previous remarks in these pages; the memorandum gives no fresh information on the subject, and we are therefore unable to enter further into the merits of the case.

"RAPID TRANSIT" DISCUSSION AT NEW YORK.

MR. FRANK J. SPRAGUE has recently made heroic efforts to produce some sensation with his rapid transit scheme for New York, and he has obtained the ear of the reporter of a newspaper called the *Commercial Advertiser*, the entire front page of which was recently filled with remarks in Mr. Sprague's pompous, dogmatic style. The New York Electric Club, at its monthly dinner on the 27th of last month, took up the discussion of this problem, and from a report of this meeting we note a few interesting observations.

Mr. McNamara, President of the Albany City Railway, expressed his opinion that rapid transit for all large cities would be found in underground railways, but that cities of less than 500,000 inhabitants must be content to have such rapid transit as may be afforded by means of surface roads. In his opinion, all roads in the near future will be operated by means of power transmitted by electricity in some form.

Mr. F. H. Monks, of the West End Street Railway of Boston, wrote: Having given this subject most careful consideration, I am constrained to believe that a four-track elevated road, allowing two tracks for express trains and two tracks for way service, built through the congested part of a city to the suburbs, would meet the needs of the city for many years.

Mr. F. S. Pearson, of Boston, expressed the belief that in New York a tunnel system and four tracks would meet the exigencies of the case, with electricity as a motive power.

Mr. Sprague spoke, and gave a summary of the newspaper interview already referred to. He gave some statistics about the railway traffic in the Empire City, and the number of passengers carried by other railways, together with receipts and operating expenses. He advocated the underground railway with electric power, similar to the City and South London Railway; but, of course, with a much greater capacity.

Mr. C. O. Mailloux discussed the rapid transit problem in Washington, where he is putting in a plant for 40 storage battery cars. Congress forbids overhead conductors.

Mr. Louis Sterne, the representative of Mr. J. Greathead, of London, spoke at considerable length on the railway, tramway, omnibus, and cab traffic in London. After describing the construction of the tunnels of the City and South London line, he said that the Americans will not be slow in adopting the improvements thus developed in Great Britain, and which will make underground means of transit as safe and as healthful as the surface roads have been until now. Mr. Sterne remarked that the Hudson River tunnel is now being built on the Greathead system, and that they are advancing there at the rate of 10 feet a day. Recently they made 15 feet a day.

Mr. Charles Emery drew comparisons between steam locomotive engines and triple expansion stationary steam engines, which are very economical; the economy of these, however, disappears in the dynamos, conductors, and motors of electric railways. Unfortunately, he said, you have all to use steam engines as yet. We therefore consider that steam is a necessity of the case, but that on account of the gases which accumulate in the tunnels, the electric motor has solved the difficulty of running through places where steam cannot go.

Mr. Edward Weston contended that in the steam locomotive we have to deal with a very different problem from what we have to deal with in the electric motor. In the electric motor the efficiency does not decrease very perceptibly with a reasonable decrease in size of the motor. In the steam engine, on the other hand, it does decrease with a reasonable decrease in size. Small electric motors can be made of nearly the same efficiency as larger ones. Such being the case, small motors applied to the axles of the cars will yield vastly greater results, and better results than a single steam engine located at the head of the train. The tractive force in the case of a steam locomotive must all be put in the locomotive. We all know how many tons have to be put on a locomotive in order to get that tractive force, and how far that may be reduced, but how far the efficiency of the electric method may be made to exceed in general that of the steam system, will be better understood when that question is more thoroughly experimented on and studied than it has been so far. In considering the question of what is the best means of rapid transit for a city like New York, we have a number of problems to deal with outside of the question of efficiency or economy. There must be convenience, quickness of stopping and starting, and everyone will concede that the lighter the parts that are to be moved, the quicker we can stop and the quicker we can start, the less is the wear and tear, and the less is the strain on our apparatus and generator. Consequently the electrical system should possess an enormous advantage over any steam system by reason of the very fact that, from the lighter weights we have to carry in proportion to the power developed, we could stop and start vastly quicker without injury to the machinery. In the electric motor we have no reciprocating parts. The strains are all tangential, and that ought to aid greatly in running and maintenance. The electric motor of to-day is not what the electric motor of a few years hence will be. With skill, ingenuity and care, there was no question in the speaker's mind about the development of rapid transit in New York or any other city by means of electricity. Mr. Weston posed as a prophet, and made, in conclusion, some reference to the probability of obtaining effective pyromagnetic generators, and he pointed out that electric currents had already been successfully derived from the oxidation of carbon without the application of heat.

SLOW-SPEED TRAMCAR MOTORS.

OWING to the rapid destruction of pinions of small diameter running at high velocities and under unfavourable conditions generally, it has become the practice, of late, in America to construct slow-speed motors. Thus, instead of running armatures at 1,000 or more revolutions per minute, they are made to give a normal speed of 400; this slower speed removes the necessity of countershafts and does away with one pair of toothed wheels. In order to obtain this result several makers have resorted to multipolar field magnets, and the extra weight of the motor is partially compensated for by the saving of one pinion and one spur wheel.

We have on former occasions referred to the improvements in the direction of slow speed effected by the Edison and Thomson-Houston Companies, and their example is now followed by Westinghouse, Baxter and others. The new Westinghouse motor has four poles. The entire field magnet consists of two iron castings arranged in the form of a ring from the internal surface of which the pole pieces project. The armature is of the drum type, the core of which has deep slots containing the copper wire, and when finished the drum presents a smooth outer surface. The field castings are hinged, and can be readily swung back, thus giving easy access to the magnets and armature. The armature can also be readily taken out and lowered into the car pit, so that it is not necessary to remove the frame of the motor from the car truck when repairs to any one part is necessary. The ratio of the gear between the armature spindle and the car axle is 3·3 to 1. The spur wheel and pinion are surrounded by a cast iron casing, which is partially filled with oil for the perfect lubrication of the gear, thus increasing the life of the mechanism, and to some extent deadening the noise usually caused by high speed pinions.

The Baxter Electric Motor Company employs an 8-pole machine containing a Gramme armature revolving at 420 revolutions per minute. In this case also the one pair of wheels is enclosed within a dust-tight box partially filled with oil.

It is astonishing that American electric traction engineers have only just found out the advantages of protected and self-lubricating gearing, which was advocated and used in England many years ago; Reckenzaun adopted it on his electric car in 1883, and has recommended it ever since.

The Post Office. To emphasise our strictures upon the management of State Departments, and exhibit the density of the official mind there comes the additional evidence furnished by the Postmaster-General's action with regard to the Boy Messengers Company. The extent to which the company was justified in proceeding with its business requires much more careful consideration than it has yet received by the public, but it is unfortunately the fact that only when the initiative is taken by private enterprise, does sleepy Officialism wake up at St. Martin's le Grand. It is always the same; we are absolutely without knowledge of a single instance of Departmental reform from within, and are daily confronted with the fact that the only possible reforms—from without—have to be fought for inch by inch, in the face of the strongest opposition from the powers that rule. Who does not know that Mr. Rowland Hill encountered the greatest resistance from the Post Office employés before his reforms were adopted, or that when the electric telegraph was first brought to the notice of the Government, Officialism promptly dismissed its claims with the reply that a very good semaphore system existed in which they had all that they required. The State always has been and always will be a stumbling block in the way of industrial progress; even as regards the penny post itself, two centuries ago we should probably have had this, but for the interference of the Government. As far back "as in the reign of Charles II., William Dockwray, an enterprising citizen of London, set up, at great expense, a penny post, which delivered letters and parcels six or eight times a day in the busy and crowded streets near the Exchange, and four times a day in the outskirts of the capital." So Macaulay tells us, but he adds that "as soon as it became clear that the speculation would be lucrative, the Duke of York complained of it as an infraction of his monopoly, and the courts of law decided in his favour." The action of the Government with reference to telephony is recent history, and none will deny that telephonic progress in this country has been hampered by officialism. Verily Mr. Raikes and M. Jules Roche may congratulate themselves on telephonic communication having been established between London and Paris, but had it not been for the action of the State, on this and on the other side of the Channel, speaking between the English and French capitals would have been an accomplished fact six years ago. This important truth seems to have escaped the attention of all the journals which indulged in such a lively fanfare, but truth it is all the same, and while the achievement at last is due to the Post Office, at the doors of the same department lies the prohibition, which by its policy was placed on private enterprise.

In the Balance. MR. FERRANTI possibly feels deeply grateful to the Chairman of the London Electric Supply Corporation. Mr. J. S. Forbes has a marvellous gift of impressing shareholders with the apparent truth of his utterances, and his remarks at the recent meeting of the Company may be ranked amongst the best of his oratorical flights, but surely the investors whose money is locked up in this venture, are beginning to tire of the oft told tale that Mr. Ferranti is always finding out something new. It is almost time that we should definitely learn which way the tide of fortune will turn with a scheme which Mr. Forbes himself describes as of the nature of an experiment—"a very costly experiment if it should fail, and *probably* a very successful one if it should succeed." There are not wanting men who, quite impartial, have watched Mr. Ferranti's scheme from its inception, and who now more than ever believe that high tension will, before very long, resolve itself into a pressure not exceeeding 2,000 volts, and we shall not feel the least surprise to learn that Deptford will shortly be working at 5,000 volts as a maximum.

AN ATTACK UPON THE DISSOCIATION THEORY OF ARRHENIUS.

In 1888, some exceptions to Van't Hoff's celebrated law for osmotic pressure in solutions, in cases when the pressure is greater than it theoretically should be, were explained by S. Arrhenius, on the assumption that the molecules of the dissolved salt have undergone dissociation. (*Vide Zeit. Physik. Chem.*, Vol. i., p. 631.)

The hypothesis propounded by Clausius in the case of electrolytes, assumes that a partial dissociation of the salt into its ions takes place, and it was surmised that if it were only possible to ascertain to what extent this partial dissociation takes place, it would still be possible to apply Van't Hoff's law for calculating the osmotic pressure.

In the paper to which we have referred, Arrhenius termed the molecules of an electrolyte, which he assumed to exist dissociated in solution, the *active* molecules, and the rest, which remain intact, the *inactive* molecules. He also termed the ratio between the number of active molecules, and the sum of the active and inactive molecules, the *activity coefficient* α (Lodge's dissociation ratio). This number is the ratio between the actual molecular conductivity of the solution and the limiting value which it approaches with increasing dilution.

When α is known, Van't Hoff's coefficient i, which is the ratio between the osmotic pressure which a substance exercises and that which it would exercise if composed solely of inactive molecules, may readily be calculated. For i is equal to the sum of the inactive molecules and the number of ions, divided by the whole number of active and inactive molecules.

Hence, if m is the number of inactive and n that of the active molecules, and k the number of ions into which each active molecule separates, then

$$i = \frac{m + k\,n}{m + n}$$

or since $\alpha = \frac{n}{m + n}$,

then $i = (k - 1)\,\alpha$.

The other method of calculating the value of i, consists in dividing the observed molecular reduction in the freezing point of water produced by the substance by the number 18·5: this method is given by Van't Hoff.

The values of i in the case of a large number of salts, calculated by both these methods, was prepared by Arrhenius, and it showed a general agreement between them. From this table of results he argued the truth of his theory upon which the calculation was based, that *substances when dissolved in water dissociate.* He concluded that Van't Hoff's law holds for all substances, the exceptions being due to dissociation, and that dissociation of electrolytes always takes place in solutions increasing in amount with the dilution, until in an infinitely dilute solution active molecules only occur.

This theory has been objected to from time to time on account of the somewhat startling consequences which may be deduced from it—consequences which are well known to be of doubtful occurrence. In a recent number of the *Berichte der deutschen chemischen Gesellschaft* (*Vide* Vol. xxiii., p. 3,519), J. Traub makes a direct attack upon the hypothesis that electrolytes dissociate when in dilute aqueous solution.

The chief arguments or objections against the theory may, according to Traub, be summed up briefly as follows :—

It contradicts our ordinary conceptions of chemical affinity, since even the most stable compounds are assumed to dissociate when dissolved in water.

Very often it is found convenient to explain certain reactions in solutions by the assumption of a so-called *nascent* condition ; but all such assumptions thus based become impossible under the new hypothesis of Arrhenius.

In order to explain the fact that the ions which are assumed to exist in the free state in aqueous solutions cannot be separated from one another by diffusion, Arrhenius makes a further assumption that the ions are endowed with charges of electricity of opposite sign, and are, consequently, so dependent upon one another that they cannot be separated without the application of energy from the outside. But this is, however, to assume a dissociation when none really occurs.

Again, according to Arrhenius's theory, the colour of any particular iron should always be the same, whereas an atom of iron in the thiocyanate is red ; in Prussian blue it is blue; in ferrous sulphate it is green ; and in ferric chloride it is yellow.

Traub rather looks upon the additive properties of dilute solutions, which Arrhenius regards as of so much importance in support of his theory as a weak point. For if the hypothesis were correct, *all* the properties of dilute solutions would be of an additive nature, and, as is well known, this is by no means the case. The freezing-point reduction of a mixed solution is either equal to or less than the sum of those of its constituents, according as there is no action between the salts, or only the formation of a double salt. On the dissociation hypothesis the former only would be the case.

Further, the hypothesis flatly contradicts the "hydrate theory," ignoring the fact that from the properties of solutions the existence of hydrates has been predicted, which have subsequently been obtained in the free state.

If we accept the reasoning of Arrhenius we should be compelled to assume that even in solutions of 10 per cent. to 15 per cent. concentration, salts exist in a dissociated condition, and that in a 65 per cent. solution of silver nitrate this salt is completely dissociated.

Arrhenius's theory has received considerable support from W. Ostwald, thus in a paper about ten years ago, for which the *Zeitschrift für Physikalische Chemie* must be consulted (*Vide* Vol. ii., p. 36), he stated that the analogy which Van't Hoff has drawn between a substance in the gaseous state and the same in solution, and the hypothesis that substances in dilute solution undergo dissociation into their ions, may be tested by the application of gaseous laws to the state of solution. And he calculated the law of dilution for binary electrolytes.

Again, in the *Zeitschrift*, Vol. ii., p. 270, we find another paper in which various considerations are advanced in support of Arrhenius's theory of the dissociation of electrolytes, and he makes a further application of the law of gaseous dissociation to electrolytes, but Traub in his recent paper says that the formula obtained by Ostwald, viz.,

$$\frac{m^2}{(1 - m)\,v} = c,$$

which should be applicable to *all* binary electrolytes only holds for organic acids of low conductivity.

Although the formula may hold for some hundreds of acids, there are, it appears, an equally large number of compounds to which it is absolutely inapplicable.

The application of the gaseous laws by Arrhenius to electrolytes leads to the conclusion that the dissociation is attended in some cases with a development of heat, a result which cannot be reconciled with the idea that energy is required to separate the ions from one another.

The phenomena of electrolytic conduction are opposed to the dissociation hypothesis. For since many indifferent organic compounds have a molecular conductivity which, like that of the acids, decreases with the concentration, it would be necessary to assume for these also an electrolytic dissociation, which, however, is impossible. In the same way, all the results for the osmotic pressure, and lowering of the freezing point of organic compounds, would have to be taken as indicating that these also undergo electrolytic dissociation.

Traub also raises objections to Arrhenius's method of calculating the value of i from the conductivity (see above). The values of α are calculated for solutions containing one gramme of the substance dissolved in one litre of water. The fusing point determinations, on the other hand, apply to normal or half normal solutions. The error therefore in the series of numbers for the latter must be at least 20 per cent. The value $\alpha = 0$ is assumed for non-electrolytes but Traub argues that there is no reason why the law of Kohlrausch, namely

$$\lambda = u + v$$

should be applied to non-electrolytes at all.

Arrhenius's theory has attracted a great deal of attention, and already a good deal of work has been based upon it. We shall await with interest the answer that will be made to Traub's trenchant attack, for the results of the controversy will be of considerable importance to our knowledge of electrolytes.

COMMERCIAL MEASUREMENT OF HIGH INSULATION WIRES.*

By CARL HERING.

ALTHOUGH the measurement of the insulation resistance of a wire is a comparatively simple matter, it is by no means as simple to find the most convenient disposition of the apparatus and connections in order to make many successive tests with rapidity and reliability as, for instance, in a wire factory, when the same apparatus must also be used for other tests of the wire, such as capacity, conductivity, and locating faults. Each of these tests is comparatively simple by itself, but the disposition of the apparatus and the connections are so very different that a change from one test to another requires an entire rearrangement of the apparatus; and in the wilderness of wires at the testing table it requires time and a very clear head to avoid making a wrong connection, which would give false results or injure the apparatus. When many wires have to be tested, as in an insulated wire factory, the time lost in arranging and rearranging the connections for different tests becomes important.

Some years ago the writer had occasion to design and put into operation a testing laboratory for a large insulated wire manufacturing company,† in which the object was to make all four of these measurements with as great facility and rapidity as possible, and with the least amount of duplication of apparatus and changes in the connections. The problem was rendered more difficult by the fact that the wire had exceedingly high insulation, and therefore required very sensitive apparatus, itself highly insulated, and a high potential battery, a shock from which was so violent that it would be exceedingly unpleasant, if not dangerous, to the operator, therefore necessitating care that the operator would not have to touch the circuit itself. Besides these principal requirements there were others of more or less importance which were desired, such as facility in calibrating the galvanometer for the insulation and capacity tests, protecting the galvanometer from an accidental injuriously large current, bringing the deflection always in the same direction, dampening the oscillation, protecting the assistant from a shock at the cable when disconnecting the leads after the test, &c. With so many conditions and limitations, the problem was not a simple one. After trying numerous combinations for the connections, the system described below was found to meet all the requirements, and was the one finally adopted.

The four tests to be made are as follows: Insulation resistance and the accompanying calibration of the galvanometer (usually termed "finding the constant"); capacity and the accompanying calibration: locating faults in a reel; and lastly, measuring the conductivity of the copper wire used. The simple diagrammatic connections in each one of these four measurements are shown in figs. 1, 2, 3 and 4. For the insulation measurement, fig. 1, the battery, galvanometer, known resistance, R (100,000 ohms), and cable are connected in series; by short circuiting the cable leads, *b*, the galvanometer is calibrated; then by unplugging the cable leads, *b*, and short circuiting the resistance, R, the cable insulation is measured. The connections for the capacity measurement, fig. 2, are quite similar, substituting the condenser at *a* for the resistance and introducing a discharging wire, and the necessary discharge key. The connections for locating faults, fig. 3, are totally different; the two ends of the copper cable are connected to the two ends of a Wheatstone bridge wire, W B, thus forming with this bridge wire the four arms of a simple Wheatstone bridge, of which the fault in the cable—that is, the internal contact between the copper and the lead coating (or water bath)—forms one of the terminals of the bridge to which the battery is attached as shown. The details of this test will be further discussed below. The connections for the conductivity test, fig. 4, are those of a simple Wheatstone bridge, including a known standard resistance, R.

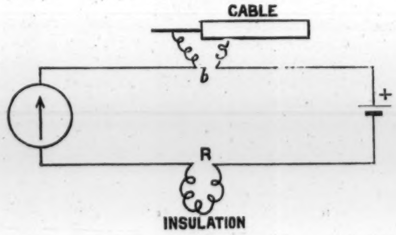

FIG. 1.

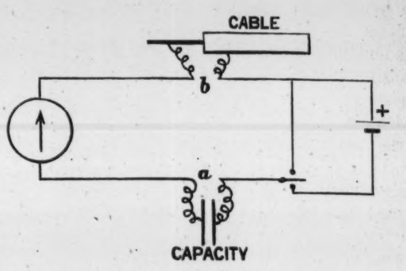

FIG. 2.

The combination of all these connections for all four tests, and including all the accessory apparatus, is shown in fig. 5. In this all the connections at the testing table are permanent; not a single connection need be changed in going from one test to another, all changes being made solely by means of the plugs on the resistance box. Furthermore, no piece of apparatus is duplicated. In one case only it was preferable to disconnect two long leads when not in use, merely to eliminate a small error which would otherwise be introduced, owing to the inductive capacity of these leads, to the slight leakage through them, or to their possible contact with the floor or walls at their distant ends. This arrangement of parts requires, therefore, merely the plugging or unplugging of two out of the four infinity plugs on the resistance box to change over from one test to another. With such simple changes the possibility of making a mistake in the connections is practically eliminated.

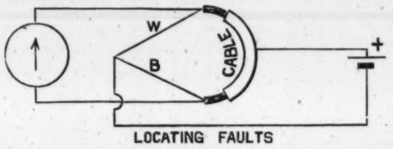

FIG. 3.

The name of each piece of apparatus is given on the diagram, and therefore needs no further mention. A detailed description of some of the apparatus which was specially constructed for this purpose—namely, the battery and the metre bridge—will follow the description of the tests. Four very well insulated leads, numbered I., II., III., and IV., in fig. 5 were laid from the testing table to the cable room, about 100 feet distant; there was also a speaking tube for giving signals and communicating. For insulation and capacity tests, leads III. and IV., which are not in use, were disconnected from their terminals, C and D, at the box, merely as a precaution, because their insulation resistance and their capacity might introduce very slight errors, and their free ends in the cable room might come in contact with the ground. Except for these reasons, they might be left permanently connected.

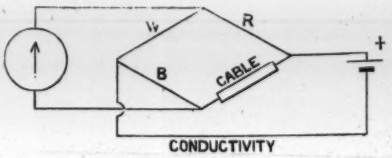

FIG. 4.

Insulation Test.—To get the constant of the galvanometer, plug up *b* and *a*, thus cutting out the cable and condenser, and unplug all the others. Use 10 cells by turning the battery switch. Depress and lock and trigger key, which in this test is a mere battery key, and which merely closes the circuit. The galvanometer key merely shunts the galvanometer, thereby keeping it at zero when not in use, protecting it from an accidentally large current, and enabling one, by proper manipulation, to "catch" the deflection and bring the needle to rest more quickly. The reversing key is set at the beginning of each test, so that the deflection is always in the same direction. The constant is thus obtained with 10 cells, 100,000 ohms, and the lowest resistance shunt. To measure the cable insulation, unplug *b*, switch over to 200 cells, and then proceed as before. Note the time when the trigger key is depressed in order that the reading may be taken at the end of one minute or any other desired and fixed time. Owing to the possibility that the cable may be a bad one, it is best to try it with 10 cells first, and with the lowest resistance shunt, leaving the 100,000 ohms in circuit: if it is good, there will be no appreciable deflection, but if bad, there will be a deflection which, however, can never exceed that obtained in taking the constant, and the nearer the deflection is to the latter, the nearer the fault is to a dead cross. By proceeding thus, the galvanometer and battery are protected from injury should the cable be bad; furthermore, the extent of the fault is also given thereby. If it is a good cable, proceed to cut out the shunts and to plug up the 100,000 ohms, provided it is of sufficient importance to affect the total resistance. This takes but a few seconds, so that by the time the minute is over the galvanometer deflection is steady, and can be read. When through, release the galvanometer key, "catching" the deflection at zero to stop the oscillations and release the trigger key, which will disconnect the battery and discharge the cable, so as to prevent the assistant in the cable room from receiving a shock on disconnecting the cable, which would be a very violent one from a 400 volt battery, as in this case. Care should be taken to connect lead No. II. to the outside of the cable, or to the tank, as that lead represents the positive pole, which, in cable testing, should always be the ground pole. Care should also be taken not to touch the metal parts of the trigger key, as a violent shock will be obtained if the operator is grounded, as is generally the case.

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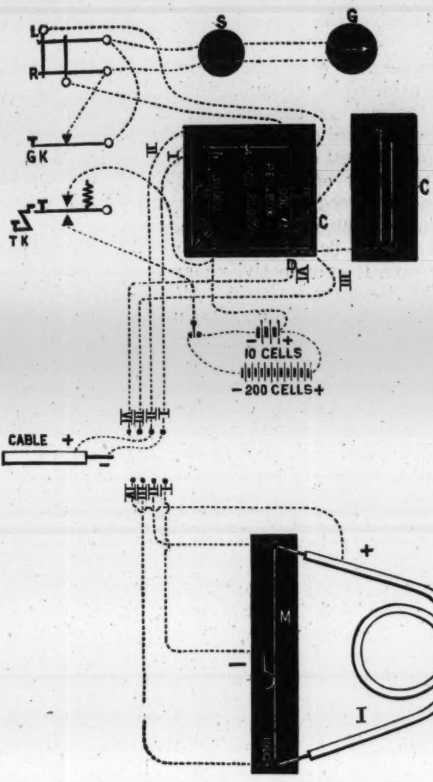
* *Electrical World*, New York.

† Cobb Vulcanite Wire Company, Wilmington, Del.



Shunt; G, Galvanometer; G, K, Galvanometer Key; T, K, Trigger Key; C, Condenser; M, Metre Bridge; I, Inside end of reel.

FIG. 5.—CONNECTIONS FOR CALIBRATION, INSULATION, CAPACITY, LOCATING FAULTS, CONDUCTIVITY.

It will be noticed that the galvanometer, its accessories and its key (which is the only one touched during the reading of the deflection), are all on the ground side of the circuit, so that there will be no tendency to leakage through them or the operator. If they were on the other side of the circuit, the leakage through them, with such a high tension battery (400 volts) and such high insulation cables (up to 100,000 megohms), may become greater than that through the cable. Great difficulty was experienced at first on this account, but it was completely overcome by the above arrangement. It requires, however, that the battery be well insulated from the ground, which was very simple in this case, as it was placed on hard rubber "stilts." Another method is to suspend the whole battery shelf from the ceiling by means of oily cords.

It will be noticed that in this system of connections the galvanometer key protects the galvanometer from the first charge which the cable receives, and which would otherwise set the needle into very violent oscillations, requiring more than the limited time of one minute to come to rest. When a "German" scale is used, which has the zero at one end instead of in the middle, as in the "English" scales, it will facilitate the subtractions to have the deflections read *up* the scale instead of *down*. The galvanometer zero should for the same reason be set (by moving the scale) so as to correspond to a simple number, like 10 or 20.

Assuming that the insulation is measured with no shunt and full battery, and that the constant is measured as above described, and with the $\frac{1}{1000}$th shunt, then the constant (viz., the deflection per megohm with no shunt and full battery) will be equal to the deflection × 1,000 × battery ratio (in this case 20) ÷ 10. This constant, divided by the deflection obtained with the cable, will give the insulation in megohms. This latter, multiplied by the length of reel in feet, divided by 5,280, will give the insulation in megohms per mile; or if the mileage of the cable is known, multiply the insulation of the reel by its mileage to get the insulation in megohms per mile.

Capacity Test.—To get the constant, unplug the condenser at *a*, insert the plug at *b*, to cut out the cable, and plug up the 100,000 ohms. Use the proper number of cells to get a good deflection—in this case 10 cells—and commutate the receiving key, as the current will be in the reverse direction from what it was for the insulation test. Depress the trigger key, which will charge the condenser, and, after allowing time for this charge, depress the galvanometer key, and when ready to read the deflection release the trigger key. To measure the capacity of the cable, unplug it at *b*, plug up the condenser at *a*, and proceed as before, using a different shunt if necessary. If there is a possibility that the cable is a bad one, it is best to proceed cautiously by unplugging the 100,000 ohms before closing the circuit. If in a few seconds after closing the circuit at the trigger key there is no appreciable deflection in the galvanometer on depressing the galvanometer key, then the cable is not bad, and the 100,000 ohms resistance may be plugged up while waiting for the cable to take up its full charge. There is no practical way of "catching" the oscillations after the deflection has been read, and it is therefore advisable to let this test follow that of the insulation, instead of preceding it, so as to give the needle time to come to rest while the assistant connects on to another cable. The galvanometer key being, when closed, a short circuit for the galvanometer, will tend to act to a slight extent to dampen the oscillations.

It will be noticed that the galvanometer key takes an important part in this test, as it prevents the *charge* from deflecting the needle, and therefore keeps the needle at rest, ready for the discharge deflection. The trigger key, as usual in such tests, prevents any loss of time taking place between the time the battery is taken off and the discharge. It is desirable in this test to have a condenser divided into tenths of a microfarad, and to unplug for the constant such a capacity that by merely changing the shunt the deflection for the cable will be about the same as for the constant, thus enabling the same battery to be used for both. To do this it must be known, of course, about what the capacity of the cable is before taking the constant. This may be done by measuring the cable first and taking the constant afterward.

If the constant was taken for the one-tenth of a microfarad, then the capacity of the cable in microfarads (if measured with the same battery) will be equal to the cable deflection divided by the constant multiplied by ·1 microfarad, and corrected for the shunt if a different one has been used. Or, for convenience in calculation, the reciprocal of the constant may be calculated once for all, and then used as a multiplier instead of a divisor. To reduce this to the capacity in microfarads per mile, multiply the capacity thus obtained by 5,280, and divide by the length of the reel in feet; or, if the mileage of the cable is known, divide the capacity by this mileage. If a different battery is used for the constant and for the cable the necessary correction must of course be made; but it is very desirable to use the same battery as described above, so as to avoid having to make this correction.

Locating Faults.—On the testing table all the changes necessary are to unplug *a* and *b*, plug up all the resistances and connect the leads III. and IV. to *c* and *d*, respectively, just as the condenser is connected; the condenser may be left in if desired, but there must not be any plugs in it, and it must not be grounded. In the cable room the two ends of the reel are connected to the ends of the metre bridge wire, as shown in fig. 5. These connections should preferably be made directly, and not by means of leads, even short ones, unless the joints are quite perfect. The fine wire leads I., II., III., IV. are connected to the cable and bridge as shown: their resistance and that of their joints are of no importance. Care should be taken to have the positive pole to ground, as shown, by using lead No. IV. as a ground wire; otherwise a fault may be sealed up while it is being located. The whole will constitute a Wheatstone bridge, of which the fault to be located is the fourth contact, the four leads being merely the connections to battery and galvanometer in the testing room. Depress the trigger key first, and then the galvanometer key; and if there is a deflection, the sliding contact on the bridge must be moved to the right or left until no deflection is obtained. From the reading on the metre bridge and the length of the cable, the position of the fault is then readily determined. There must, of course, be some means of communication between the operator and his assistant.

Among the details of the test besides those above mentioned are the following: For a low resistance or dead fault, use a low resistance battery capable of giving somewhat more current than the usual batteries for insulation tests. The trigger key should be depressed only long enough to take a reading of the galvanometer, otherwise the battery may become discharged or polarised, as the external resistance is quite low. The reversing key may, for convenience, be set so that deflection on the increasing side means that the bridge contact should be moved so as to increase the reading, and *vice versa*. The bridge should, for convenience, be graduated to 1,000 parts; the one used was one metre long, divided into millimetres. The resistance of this bridge wire should be about equal to that of the average cable to be tested, in order to give the best results. The sliding contact on the bridge was so designed that the contact had to be lifted before it could be moved along; this was done so as to avoid scraping or flattening the wire when using the bridge. This contact was furthermore constructed, so that on lifting the sliding contact the circuit was first broken at another point, in order that the spark (which may become quite great) does not occur on the resistance wire, and therefore the latter is not injured by it. For convenience in calculating the result, the outside end of the reel is connected to the zero end of this wire, and the inside end to the 1,000 end; the figure obtained will then give, directly, the length of cable which must be unreeled in order to get to the fault. This length will evidently be equal to the length of the cable multiplied by the reading of the bridge in millimetres and divided by 1,000, because, being a bridge, the distances from the fault to the two ends will be proportional to the distances from the sliding contact to the two ends of the bridge. Faults have been located in a number of instances in a No. 4 wire to within a few feet of their true value, the whole length of cable being almost half a mile. This method, therefore, admits of getting very good results. The only difficulty experienced was when the fault had a high resistance, in which case the cable should be connected to the negative pole of a dynamo or battery the positive pole of which is connected to the outside; and it should remain so connected until the fault has become one of low resistance, after which it can be located. A faulty cable being the exception, this adds very little to the work. For high resistance faults it may give better results to exchange the battery leads with the galvanometer leads, but in that case it is very important that the battery should not be grounded, and that it should be very well insulated; the battery in that case need not be of higher voltage than for a low resistance fault, because the main current does not have to pass through the fault itself.

Conductivity Test.—The connections and the bridge for this test are precisely the same as those for locating faults, only that the cable is connected in series with a known standard resistance, R (fig. 4), and the junction of the two takes the place of the fault, and is therefore connected to the end of lead No. IV. This standard resistance had better be of copper, so that no temperature correction is required. Furthermore, its resistance ought to be about that of the average cable to be measured, in order to give the best conditions for making the test. If an appreciable current is used, the standard resistance should not be made of too fine wire; for the best conditions its size should not differ too much from that of the cable. The measurement is made just like the preceding, and the reading of the bridge gives the ratio between the standard resistance and the cable, and therefore gives its actual resistance, from which, together with its size, the conductivity may be calculated.

Special Apparatus.—Besides the bridge already described above, the only special apparatus used in this laboratory was the battery. This consisted of 200 Planté accumulators, and therefore gave about 400 volts. The cells themselves were made of glass tubes or phials placed in 20 rows of 10 cells each. The ends of each of these rows were connected to the well-known Planté form of cylindrical commutator, which by a single half turn enables the cells to be connected either all in series or 10 in series and 20 in multiple arc. The plates themselves consisted of a lead wire bent into the form of an inverted U, and having one arm in each of two adjacent tubes. They may be kept insulated from each other in the tubes by packing the cell with coarse well-washed sand. The cells are charged by turning the commutator so that they are coupled 10 in series and 20 in multiple arc, and then connecting them the day before with about 20 or 25 Leclanché cells. When power can be obtained, it is preferable to use a small shunt-wound motor, such as may be found in the market, and run it as a dynamo. The resistance of such a battery is very low, and may be neglected. It is important, however, for this reason, that care should be taken not to touch the circuit when the cells are all in series, as the shock obtained is very violent. It is also necessary to guard against any accidental short-circuiting of the battery, as this discharges it. The battery may be placed next to the operator, as it occupies but a small space (2 square feet). It was insulated by placing it on four "stilts" of hard rubber rods 3 or 4 inches long. When the battery is in good condition, the electromotive force of the 200 cells may be taken as exactly 20 times that of the 20 groups in multiple, and therefore the battery ratio need not be determined by a test.

The galvanometer was adjusted in sensitiveness so as to give a full deflection for the calibration with the 100,000 ohms and 10 cells. The average resistances to be measured were between 20,000 and 30,000 megohms, though in one case a resistance of 108,000 megohms was measured. The deflections were read with a telescope and scale, as this was found preferable in may cases to the spot of light method. The galvanometer was at a distance of about 6 feet from the scale, which is double the usual distance. It was of the double coil Thomson type, made by Carpentier, in Paris. To avoid being affected by the continual trembling of the ground, it was placed on a very heavy slab of marble 4 inches thick, suspended on three wires fastened to a pier. This overcame completely the vibrations, but it is important not to touch the galvanometer itself, as it will oscillate as a body for hours when touched. A little wad of soft paper or cotton, placed between the slab and the pier, so as to cause some friction without transmitting vibration, will tend to bring the slab to rest more quickly.

It was found that with such high voltages and such a delicate galvanometer, there was what appeared to be a sort of static charging of the needle and its mica damper, the effect of which was to cause the needle to make very erratic and violent movements, rendering the instrument utterly useless. This took place even when connected to only one pole of the battery. After futile attempts to overcome this, it was finally accomplished very satisfactorily, by connecting the galvanometer circuit to the frame of the galvanometer itself. This, however, required the galvanometer to be insulated, which was done by placing it on "stilts," like some of the other instruments. After all these precautions were taken, the results were very satisfactory in every way.

Although the insulation test described above is the one generally used, it should be remembered that, although it will answer in many cases, it does not by any means prove that a lead-covered cable is good; for suppose that there was no insulation at all for a foot or two, and that by mere chance the copper did not touch the lead coating, the cable would test high, but it would be faulty in the worst way. To detect faults of such a nature, an influence machine or a Rhumkorff coil, giving a spark of, say, 1 inch, might be used. This would merely indicate whether there was a fault or not, but would not measure its resistance.

TELEPHONY IN AUSTRIA.

[FROM OUR OWN CORRESPONDENT.]

UNDER this heading the *Neue Freie Presse* publishes some interesting data on the development and extension of telephony in Austria, which I communicate to you below.

Since the first installations in 1881 this new mode of intercourse has been developed in a striking manner in Austria, as it appears from the following:—At the end of 1881 there were 154 stations for subscribers connected with the central station in Vienna, 37 of which were direct connections between two places of business belonging to the same proprietor in Vienna and its vicinity. In the beginning of 1883 the total length of wire was 1,670·3 kilometres with 453 stations for subscribers along the central net and 76 direct connections, and the first public speaking place was brought into use on April 18th, 1882, at the stock exchange in Vienna, and for 1884 there were given out 31,076 conversation cards at 20 kreutzers. To these and to the installations carried out at Linz and Bruenn by the Vienna Private Telegraph Company, there came in the course of 1883 and of the following years there were added the installations of the Consolidated Telephone Construction and Maintenance Company, Limited, at Prague, Trieste, Pilsen, Lemberg, Graz, Czernowitz, Reichenberg and Bielitz-Biala. The latest official data extend to the middle of 1889, and in this time the following new connections have been added Liesing, Berchtolsdorf, Kaltenleutgeben, Ravenstein, Singerin-Nasswald, Reichenau, St. Pölten, Warnsdorf, Aussig, Auscha and Haindorf.

According to the above statistical returns the number of urban nets reaches 28, of which 17 are worked by the State and 17 by private persons. The length of the wire has increased as follows: 1883, 4,221·4 kilometres; 1884, 5,668·3 kilometres; 1885, 6,832·6; 1886, 8,362·13 kilometres; 1887, 11,377·91 kilometres; 1888-89, 16,828·93, of which 2,085·63 kilometres belong to the State, and 14,743·8 to private undertakers.

If arranged according to the lengths of wire Vienna takes the lead. It has 8,593 kilometres as against 6,236 kilometres in 1887; Prague 1,529 as against 1,418; Triest 1,024 as against 917; Graz 997, as against 668; Bruenn 679, as against 514; Reichenberg 581, against 424; Czernowitz 304, against 250; Reichenau 233, against 75; Pilsen 225, against 215; Wiener-Neustadt 203; Neunkirchen 198; Bielitz-Biala 197, Linz-Urfahr 176, against 169; Baden 147.

The number of subscribers has increased greatly since 1883. In that year there were 1,242 subscribers; 1884, 1,979; 1885, 2,519; 1886, 3,250; 1887, 3,868; 1888—89, 4,804. The numbers for the following towns were: Vienna, 1,628, against 1,191 in 1887; Prague, 640, against 582; Trieste, 483, against 435; Brünn, 392, against 311; Graz, 341, against 283; Lemberg, 330, against 243; Reichenberg, 318, against 263; Linz-Urfahr, 186, against 169; Bielitz-Biala, 145, against 144; Pilsen, 134, against 121; Czernowitz, 111, against 107; Warndorf, 37; Reichenau, 21, against 19.

The number of interviews, including telegrams sent out telephonically and phonogramms, was in 1884, 1,883,393; 1885, 2,557,033; 1886, 3,846,048; 1887, 4,918,816; 1888—89, 6,035,579; of which 5,892,983 were conversations.

If arranged according to the externity of intercourse, the towns follow in 1888—89 as follows: Vienna, 1,446,267; Prague, 1,275,264; Trieste, 990,388; Brünn, 423,382; Reichenberg, 360,322; Linz-Urfahr, 346,853; Lemberg, 331,631; Graz, 268,058; Pilsen, 151,086; Bielitz, 137,804; Czernowitz, 76,348; Warnsdorf, 3,500.

The public speaking-rooms are 41, of which 14 are in Vienna, Prague and Trieste 2 each, Reichenau 9; the only one at Brünn is closed. The fees on the lines Brünn, Wiener-Neustadt, Neunkirchen, Reichenau, vary from 20 kreutzers to 1½ florins.

As regards the internal use of this means of intercourse, the number of conversations per subscriber are as follows:—

	Communications.	Conversations, 1888–89.	1887.
Trieste	2,088	2,050	− 2,450
Brag	2,058	1,993	+ 739
Linz-Urfahr	1,940	1,864	+ 1,436
Pilsen	1,242	1,127	+ 701
Reichenberg	1,161	1,133	+ 968
Brünn	1,154	1,077	− 1,339
Lemberg	1,075	1,005	+ 808
Bielitz-Biala	969	950	+ 965
Vienna	915	888	− 1,042
Graz	811	786	+ 619
Czernowitz	722	688	+ 721
Warnsdorf	96	95	—

Very striking is the strong falling-off in Vienna, Brünn and Trieste as compared with 1887; and the increase in Prague, Linz, Lemberg and Reichenberg. The number of persons employed is 289, as against 252 in 1887—88.

RANKIN KENNEDY'S NEW ELECTRICAL DISTRIBUTION METHOD.

By RANKIN KENNEDY.

(*Continued from page 362.*)

II.—THE SUB-STATIONS.

THIS new method is essentially a high pressure distribution system, with sub-stations supplying low pressure distribution to consumers.

The systems of high pressure distribution by means of numerous small transformers, one on each consumer's premises, are now becoming things of the past; such systems were adopted only as a starting point for high pressure distribution when consumers were few and far between; those who advocate such systems at this date are on the same level as those who advocate simple low pressure distribution, they are either extremists strongly prejudiced against any innovations, or business men in such systems whose interests are rather to keep methods as they are.

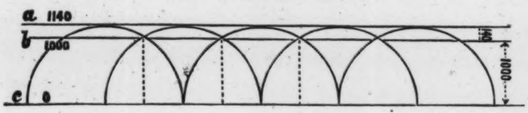
Anyone who has given the matter any serious thought must come to the conclusion that the present great diversity in the systems of supply in use, in one city even, cannot continue if electric light and power is to become popular. A system of supply universally applicable to all towns and cities alike must be evolved out of the present chaos of systems.

Recently expressed opinions by engineers who are generally considered competent would seem to point to the fact that the combination of high pressure primary distribution, with low pressure service distribution, would meet every requirement. To a limited extent this combination of distribution mains is in operation from the Deptford and also from the Chelsea generating stations; the former using alternating currents and transformers, the latter using continuous currents, accumulators, and dynamotors. Both of these distributing centres recognise the value and advantages of primary high pressure distribution with sub-stations feeding into low pressure service mains.

This new duplex pulsating system goes a step further on the road towards a universal system of distribution, in providing a generating distributing centre at high pressure, capable of feeding into low pressure service mains through sub-stations of storage batteries, dynamotors and transformers, so that instead of requiring separate generating distribution centres for each different kind of pressure-reducing substation, they may all be supplied with the high pressure primary energy from one centre and from one plant.

On this new system the storage battery sub-station is charged by the two pulsating unidirection currents superposed on each other, the one at a maximum when the other is at a minimum, so that the one compensates the rise and fall of the other. Suppose, as in diagram, fig. 1, the total rise of pressure to be 1,140 volts as indicated by line *a*, and that the two curves cut at the line *b*, equivalent to a pressure of 1,000 volts, storage batteries in series numbering 450 could be charged effectively; at no time would the E.M.F. fall below the counter E.M.F. of the batteries.

FIG. 1.



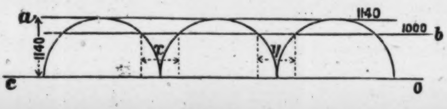


FIG. 2.

A rectified alternating current alone is not sufficient for charging storage batteries, as shown in diagram (fig. 2), which illustrates one alternating current rectified. Here the E.M.F. rises to 1,140 and falls to zero, consequently during the whole time that the curves are below the line, say *b*, the batteries would be discharging back into the generators; this time of back discharge is shown between dotted lines at *x* and *y*.

The conditions for successful working of dynamotors for reducing the pressure at sub-stations are precisely similar to those for working storage batteries; the E.M.Fs. must be superposed on each other in the high pressure primary armature circuit, so that at no time shall the E M.F. fall below the counter E.M.F. of the primary winding on the armature of the dynamotor, hence this armature circuit is coupled in on this new method between the mains supply the pulsating currents in series.

Any method proposing to work motors or dynamotors by means of one rectified alternating current, whether simply rectified or split up into its two component waves, labours under the very serious effects produced during the time the pulsating E.M.F. is below the counter E.M.F. of the primary or armature winding. Such proposals are, in fact, impracticable on that account alone. It must be remembered that in an electromotor with constant field and constant speed the counter E.M.F. is constant, the same as in a storage battery, while a rectified alternating current, no matter how rectified or how it may be manipulated by commutators splitting it up or recombining it, always pulsates at least 50 per cent. ± From these considerations, the author found it necessary to use two alternating currents in quadrature, rectified, the one to compensate the other in rising and falling, so as to obtain a steady E.M.F. not less at any moment than the counter E.M.F. of batteries or motors in circuit.

It is comparatively an easy matter to excite steady magnetism in a field magnet, even although the pulsations in the exciting current are great; but it is quite a different problem to maintain constant E.M.F. in opposition to another constant E.M.F., to prevent back current or back discharge. This problem is solved on this new method by the two E.M.Fs. in quadrature.

At sub-stations employing storage batteries or dynamotors as reducing plants, attendants are necessary. This is no drawback where sub-stations are important and large, but in every system of distribution it will be found very expedient to use sub-stations without attendants; this is where the transformer supplying low pressure alternating current comes in, and a very important field of operation it has before it in that capacity.

On this new method these smaller sub-stations are operated by the two pulsating currents magnetising oppositely, and thus acting as one alternating current.

The construction of these transformers does not differ from the ordinary alternating current transformer, only it has two primary windings, one for each pulsating current.

(*To be continued.*)

"A TALE OF WOE."

BY H. FRANKLIN WATTS.

IN view of the great progress of electrical invention, and the high value attached to American enterprise and genius, it is with great satisfaction that the writer asks the indulgence of the readers of the *Electrical World*, while he directs their attention to what may be called the "weakest link" in the various light, power and railway systems now in extensive operation throughout the country. The writer's idea was so fully embodied in a conversation that recently took place between himself and a prominent business man, that it is believed to be worth reporting here in brief. The gentleman in question owned the controlling interest in at least two electric light plants, and was a firm believer in the high degree of perfection that electrical machinery had attained, and its consequent ability to overcome all obstacles. He had not, probably, read the *Electrical World* as diligently as he ought, and hence was excusable for his lack of knowledge regarding the operation of the iniquitous dynamo.

On the occasion referred to he had entered the station and engaged the writer in conversation, which shortly drifted as follows: "That's the reason these things cost so much, I s'pose—they've got so much copper in them. Where is all this copper? I don't see any." Upon being informed that the copper was covered up or "insulated," he asked further: "What is it covered up for—afraid some one will see it?"

I endeavoured to explain to him that the "insulation" upon the wire was necessary to prevent contact between the different wires, which would cause "short circuits" and burn out the armature, but he interrupted me. "Do you mean to tell me that that little thin film of cloth or thread stuck on to that wire is all that prevents that armature from burning up? That armature there is worth $600." When I told him that in a modified form such was the case, his astonishment and anger knew no bounds. "If I had known that," he exclaimed, "I would have put in the Edison system."

When informed that the Edison and all other systems were the same in this respect, his disappointment was intense. "To think," he said, "that the expense of all this machinery—dynamos, engines, boilers, wire, poles and fixtures—should depend upon a little piece of rag or tape that I could scrape off with a penknife. It's the most disgusting thing I ever heard of. I don't believe Mr. G. or Mr. H. knows this. I am going to tell them about it. I thought that money put into a railroad hung upon a slim thread; the flange only had to jump 2 inches over a steel rail to send the train down the bank into the ditch and cost the company $100,000; but this electric business is worse than that, for the stuff has only to jump $\frac{1}{16}$th of an inch, or less, through a piece of cotton to knock out the whole thing, and there are millions invested in it. I thought you electricians had better sense than that. I thought you had some science, and that your machines were reliable; but this cotton-string business is the most absurd, unscientific and senseless thing I ever dreamed of."

Without continuing this "tale of woe," does it not seem that there is a great deal of truth in the statements quoted, and that the great electric enterprises are indeed hung upon a "slim thread?" The number of burned-out armatures requiring rewinding in the United States in one single year would be most astonishing if the grim facts were made public. In alternating machines, for example, the heat given off from the armature is very great, and results in and is a slow process of carbonising the cotton insulation upon the wire and rendering it a conductor of electricity.

Then, again, the crowding together of the wires in the effort to squeeze the greatest possible number of turns into a limited space, with cotton only intervening, is indeed "unscientific," to say the least. Aside from all this, to put 500 volts into a railroad motor, one side of which is grounded, and to allow water to splash upon the coils covered only with cotton, is taking too many chances. Yet just such chances are continually being taken by the various light and power companies, and then they wonder why grounds and burnouts occur.

Again, our dynamos are more electrical than mechanical. This is especially true of alternating machines in which the field is of great power and the induction is in consequence very great. The fact does not appear to be recognised that it is the armature coils of a dynamo that absorb power. These coils in the alternating machines are laid upon a perfectly smooth and slippery core, being held in place by the band wires, and yet these coils absorb, perhaps, the full power of a large engine. If a first-class short circuit occurs, these coils will often stop instantly, while the core, being keyed to the shaft, still rotates until, getting wedged in the poles, the belt is thrown off. Is this method of constructing armatures and insulating them scientific or unscientific?

What is required is an insulating material capable of uniting with the coils, or rather adhering to the coils and also the iron core of the armature, holding each individual convolution of wire in place with the rigidity of iron. This material should, of course, be quite hard—not too brittle—and heat resisting, and should be capable of allowing the conductors that it encloses to become red-hot and still continue to operate. Mr. Ferranti, in London, is using a compound of glass and sulphur, and pours it hot upon the coils, which are otherwise insulated with porcelain or mica. This insulation is, in fact, the secret of his ability to employ and maintain a pressure of 10,000 volts.

Let a little of the American genius now devoted to the conduit railway system be turned in the direction the writer has now pointed out, and one of the greatest electrical achievements of the age will be accomplished. A ground or a burn-out would thus be not only "unlikely to occur," but *absolutely impossible* so far as the machine itself is concerned.

We want this new insulating compound to use upon the motors and generators of New York's underground electric railway. Every motor and generator should have its armature and field coils embedded in it. Then, and then only, will the electric motor be able to compete with the steam locomotive in point of reliability on local and ex-territorial lines where the limit of speed now attained by the present locomotive has been outgrown.

GAS AND ELECTRIC LIGHTING.

In the yearly report of the German Continental Cas Company some interesting particulars are given regarding the employment of gas engines in large electric light installations. The report states that the company is continually endeavouring to increase the consumption of gas, not only for heating and power purposes, but also in decreasing the cost of installation. The construction of larger gas engines than those generally used has been already successfully commenced, and during last year Zwilling gas engines of 140 effective horse-power were built on the Otto principle. When the central electrical light station of the company in Dessaw was built in 1886, the largest gas motor in use was of 60 H.P., but in 1889 the first gas engine of 100 H.P. with four cylinders was constructed. Experience up to the present justifies the idea that the construction of gas engines is by no means confined to small motors, but that their use is constantly in the direction of engines of greater powers, since the consumption of gas per horse-power diminishes as the engines are made of larger powers.

This progress is important for the production of the electric light in large centres. As one instance of this, the company cites the fact that with the excellent results obtained from its accumulators—an efficiency of 78·9 per cent.—one Zwilling gas engine of 140 H.P. can, with dynamo and batteries, keep 4,000 glow lamps alight simultaneously, these corresponding to about 5,000 16-C.P. lamps installed. Thus, three motors of this power in a central station can supply 12,000 lamps or, say, 15,000 put up. This number of lamps will at present suffice for all small and medium sized towns, and even for large cities where the first installation does not exceed ·15,000 lamps. It is fair to assume that even gas engines of 140 H.P. will not long remain the largest, as others of higher powers will probably be constructed.

The uniting of such electric stations with neighbouring gas works not only reduces the administrative expenses, but it has also the great advantage that the works can be erected in the centre of the town, owing to the abolition of the smoke nuisance and danger of explosion; it requires less ground surface and less water, and reduces the length and therefore the expenses of the electric light cables. The consumption of gas in the company's lighting district has steadily increased, notwithstanding the extension in the use of electrical illumination, the former business holding, as in previous years, the first place. The competition of petroleum has been slightly less, and even the use of this illuminant will, with large gasworks, be supplanted by the employment of regenerative lamps.—*Elektricitäts Zeitung*.

THE EFFECT OF PRESSURE UPON THE ELECTRICAL CONDUCTIVITY OF LIQUIDS.

It is an elementary fact that liquids are far worse conductors of electricity than metals, and this is no doubt to be accounted for by the difference in their physical state. The conductivity of a metal is diminished when its temperature is raised, or in other words, it decreases as the liquid condition is approached, since every metal may be converted into the liquid form, if only it be subject to a sufficiented degree of heat.

The law of this diminution is expressed by the formula,

$$K_t = K_o\,(1 - a\,t + b\,t^2),$$

where K_t and K_o are the conductivities at $t°$ and $0°$ respectively, and a and b are constants, which are probably the same for all pure metals.

In the case of a solution of a metallic salt, acid, &c., the conducting power is very low indeed, compared say with that of silver, but it increases with the concentration, although the proportional increase is not direct. The influence of concentraton has been studied somewhat exhaustively.

The influence of temperature upon the conductivity of liquids and fused conductors has also received considerable attention, so has the influence of light, especially in the case of selenium, but the effect of *pressure* upon the electrical conductivity of liquids has not come in for so much attention.

An American physicist, C. Barns, has recently been examining the value of the electrical conductivity of liquids under the condiition of more or less increased pressure. The results of his experiments are published in the American *Journal of Science*, series 3., vol. iv., pp. 219-222, where they may be consulted in detail.

The paper is rather an abstruse one, and we give our readers the pith of his results with as little of the mathematics as an abstract of such a paper can reasonably contain.

One of the most interesting liquids which Barns placed under examination was mercury. Pressures of from ten to four hundred atmospheres were employed, and the mercury (an ordinary commercial sample) was subjected to these pressures isothermally. The value for the decrement $\frac{\delta R}{R}$ of the specific electrical resistance, R, corresponding with the increment of pressure, δP, is found from

$$\frac{-\delta R}{R} = 30 \times 10^{-}\ \delta P.$$

Now if v represent the volume, then

$$\frac{-\delta v}{v} = 3 \times 10^{-}\ \delta P$$

and hence

$$\frac{\delta R}{R} = 10\,\frac{\delta v}{v}$$

This follows from the results of Grassi and others.

If θ be the symbol of temperature, then the following approximate results apply, at ordinary pressures and temperatures, isopiestically, namely,

$$\frac{\delta R'}{R'} = 800 \times 10^{-6} \delta \theta$$

and

$$\frac{\delta r}{r} = 180 \times 10^{-6} \delta \theta$$

Hence

$$\frac{\delta R'}{R'} = 4{\cdot}4 \frac{\delta r}{r}$$

when R' refers to the electrical resistance considered in its thermal relations.

The behaviour of zinc sulphate was also examined, the pressures applied being as before from ten to four hundred atmospheres, and Barns found that similar expressions to those above apply, but with somewhat less accuracy.

These results were expressed graphically, and the pressures in atmospheres or volume decrements per unit of volume, were found to be linear functions of the corresponding decrements or increments of electrical resistance per unit of resistance.

Rectilinear curves were also obtained for thermal change of resistance $\frac{\delta R'}{R'}$ co-ordinated with volume decrement.

In order to bring the compression *loci* into coincidence with the thermal *loci*, the former must in each case be rotated around the origin in a "counter-clock-wire" direction.

The angle of rotation for zinc sulphate solution is much greater than it is for mercury. Hence follows the remarkable result that, both in the case of the metal and of the electrolyte, the effect of the isothermal compression is a decrement of resistance nearly proportional to pressure, and by deduction, that the immediate electrical effect of a rise of temperature $\frac{\delta R'}{R} - \frac{\delta R}{R}$ is a decrement of specific resistance.

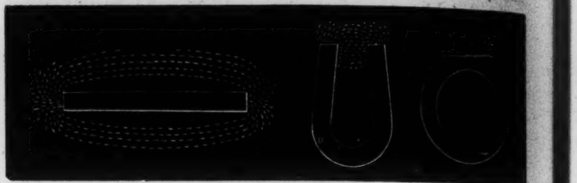
From this it seems that in this instance there is an inherent similarity between the metallic and the electrolytic conduction.

These results are extremely interesting, although the calculations by means of which they have been deduced, do not possess much attraction to such minds as have no particular mathematical bias. It seems likely that this line of research may lead to some important deductions which will throw light upon the subject of electrical conductivity in general.

ON CHANGE OF FORM AFFECTING A MAGNETIC FIELD.*

By A. E. DOLBEAR.

HITHERTO the study of a magnetic field has been the study of the so-called lines of force radiating from the poles of magnets, either electro or permanent, and so far as magnetism has been utilised in the arts, the changes in this external field have been brought about by the movements of an armature, having for its function to determine the direction and consequent density of the field. Such is the case in the instruments used in the telegraph, the telephone, dynamos and motors. Sometimes conducting wires are so mounted in the field that their movement gives rise to electric currents, which signifies that the energy producing the tension in the field is absorbed in some measure by the moving wires, and is transformed into an electric current. In each of these cases, the magnet producing the field is stationary, that is, changes in the magnetic field produced by it, are due to motions external to the magnet itself and may be that of an armature, of moving wire, or of its own bodily change of position—a kind which is comparable with what is called external motion, in thermo-dynamics, to distinguish from internal motions or such as take place when the body changes its form. So far as I am aware, no study has been made of the effects of changing the form of a magnetic body on its field, or of the reaction upon itself, of its magnetic condition due to a periodic change of form. Of course, it has been known for a long time that the form of the magnetic field depended upon the form of the magnet itself. For a straight bar magnet, this field is familiarly known by the arrangement of iron filings forming curved lines from each pole re-entering the opposite pole, as in fig. 1. When the iron is bent into a U form or horse-shoe magnet, fig. 2, the field is contracted to little more than the space between the poles. These forms of magnets have been *permanent* ones for the purpose for which the magnets were made.

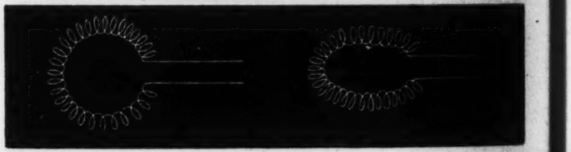


FIGS. 1, 2 AND 3.

In the case of an induction coil, whether of one form or another, the magnetic change produced by it, has been and is due to the *electric* change produced upon it by an electric circuit provided with intermittent or alternating currents.

Within a few years attention has been called to the nature of the external field, as being a part of what is now known as the magnetic circuit, which consist of these *rings* or closed circuits of lines of force, all originating in the iron part of the circuit, and for *conducting* which, iron is by far the best. The poles of the magnet are simply the parts of the iron where the lines enter and leave, and they may be in any place. Usually they are at the ends of the iron, but not necessarily so. Whenever iron is placed in the magnetic field, these lines crowd into it, as it is so much better conducting than the ether. When the iron is made into a ring, fig. 3, and then magnetised, there is no external polarity and, consequently, no external field, provided that the iron has sufficient conducting cross section at every part.

The following experiments have been tried, to determine what effects, if any, are produced upon a magnetic field by changing the form of a magnet. It was thought, at first, that if a helix was coiled into a circle, fig. 4, and a current was present in it, a change in its form to that shown in fig. 5 would produce a corresponding change in the magnetic field external to the coil, especially noticeable if a flexible iron ring was enclosed in the helix so as to condense the magnetic field. This was put to the test in the following manner:—



FIGS. 4 AND 5.

(I.) A coil, similar to the one described above, but containing a solid ring of iron, about eight inches in diameter and an inch thick, had its coil put in circuit with a reflecting galvanometer of low resistance, and at such a distance from it that magnetic fields external to its circuit could not act upon it. Another coil, made about a flexible ring of iron wire, was put in circuit with a battery so as to magnetise the ring strongly. Then, with one ring parallel to the other, the flexible one was made suddenly to assume an elliptical form, fig. 6. Each such change in form from one ellipse to another at right angles to it, gave a deflection of the needle to the right or left, and uniformly for a given phase of change. It was also observed that the direction of the deflection was reversed when the flexible ring was turned the other side up.

(II.) The same flexible ring, used in the same way, but without the current through it, gave substantially the same results. Of course the ring was permanently magnetised, and the change might have been inferred.

(III.) As the same kind of motion, due to change of form, is taking place when a ring is vibrating at its harmonic rate, producing what we call sound vibrations, it was thought probable that a magnetised ring, having a coil of wire about it, in connection with a telephone, would set up vibratory currents when it was struck; and this was found to be true, for when the coil containing the heavy iron core was put in circuit with a telephone in another room, the sound of the stroke and the pitch of the ring could plainly be heard. In the first case, the number of turns of wire was small, perhaps fifty or thereabouts. I, therefore, had two larger rings made, each about one foot in diameter and half an inch thick.

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* Based on a paper read before the American Academy of Arts and Sciences, and published in the New York *Electrical Engineer*.

(IV.) One of these was wound with six or seven hundred turns of No. 32 wire. Before it was magnetised it was connected with the telephone and tested for its magnetic condition by striking. The ring could plainly be heard, which showed that it had some degree of magnetism.

(V.) Then, about two hundred turns of coarse wire was wound upon it and a strong current sent through it to magnetise it. After this magnetising coil had been removed, the ring was again tested as in IV. The sound was very much louder. Indeed, the telephone could be held a foot from the ear and be heard.

(VI.) With the ring in V. still in circuit, the companion ring, without any wire upon it, was brought near it and struck. The sound was easily heard in the telephone circuit.

(VII.) This second ring was now magnetised in the same way as the first, when the magnetising helix was removed, and the experiment VI. repeated. The sound was *very* much louder.

(VIII.) The ring was now struck and moved away from the first ring by stages of an inch or two at a time. It was found possible to hear its pitch in the second circuit, when it was a yard or more away from it.

(XI.) As the pitch of the two rings was not quite the same, the higher one was loaded so as to bring them to unison. The sound was then louder and more persistent than before. This gave evidence that it was a case of sympathetic vibration, while the former ones were forced vibrations.

(X.) A common horse-shoe permanent magnet, with legs about 6 inches long, had perhaps 50 ohms of No. 32 wire wound about the bend, and this was put in circuit with the telephone, as shown in fig. 8, and struck like a tuning fork. The sound was remarkably loud. It was too strong to be held comfortably at the ear.

(XI.) A coil of wire was now put about the middle of a piece of gas pipe, which was without permanent magnetism. The piece of pipe was about 4 feet long and $\frac{5}{8}$th of an inch in diameter. This, when in connection with the telephone, was struck two or three times a second, with a piece of brass rod, and while being thus struck, it was rotated from the magnetic meridian to a position at right angles to it.

The difference in the loudness of the sound, between the position in the meridian and away from it, was very marked.

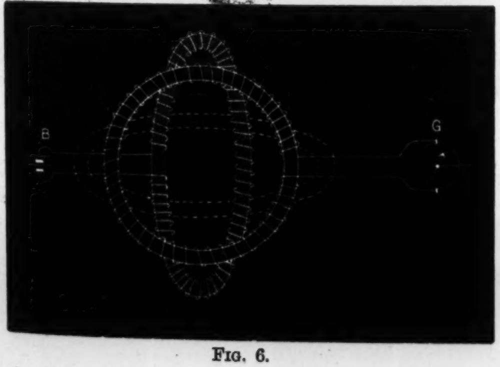
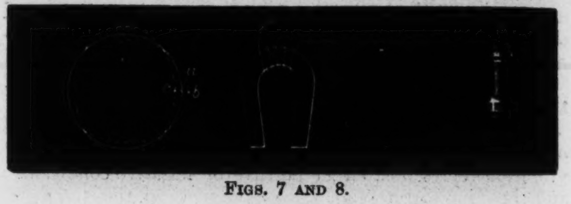


FIG. 6.

It is therefore shown to be possible to determine the points of the compass with a telephone, a coil, and an iron rod.

(XII.) A second flexible ring was now made, about a foot in diameter, consisting of a bundle of soft iron wire, the ends being roughly braided and twisted together, the thickness of this was rather less than half an inch. This was covered by a rubber tape wound spirally around it, the better to secure stability of form and insulation. Then 4·6 ohms of No. 21 wire was wound about it its entire length, making probably 1,000 turns. It was then magnetised by a current from 3 secondary cells having 6 volts, giving a magnetising current of about 1,300 ampère turns, leaving it a ring magnet. The terminals were then connected with the terminals of a reflecting galvanometer with a resistance of ·67 ohms. Very slight changes in the form of the ring, either by pulling or pushing, gave decided movements to the needle, while larger amplitude gave 30 to 40 degrees deflection.

(XIII.) It was noticed, also, that the direction of the current depended not only upon the direction of the motion changing the form, but also upon the direction of the motion with reference to the normal shape of the ring. Thus, if the ring be drawn into a horizontal ellipse, the current will move the galvanometer needle, say to the right. When it is brought back to the circular form, the circuit is reversed. If the motion be continued so as to produce a vertical ellipse, the current will be in the same direction as that produced at first by a motion exactly opposite in direction; so that for a complete cycle of vibratory changes, four currents are generated, two direct and two reverse. For instance, in fig. 7, when a point *a* is moved to *b* the induced current may be direct, but it will also be direct if point *a* be moved to *c*, so that for the movement, *a b c*, there are currents that may be thus represented.



FIGS. 7 AND 8.

(XIV.) One of the iron rings, before mentioned, a heavy one about 8 inches in diameter and an inch and a half thick, having coarse wire wound upon it nearly covering the ring, was connected with the galvanometer as before, and the ring was struck by a brass rod. The needle instantly swung through a wide angle. Struck again, it moved as before but not through so wide an angle, and a half dozen blows knocked nearly all the magnetism out of the ring. This was then detached from the galvanometer and magnetised as before, when it again gave the same large deflection it gave at first. The same conditions were tried with other rings and in each case it was found that a vigorous stroke upon the ring magnet had the same destroying effect upon the magnetism, as it is known to have upon magnets having external fields.

The flexible ring was now put in circuit again, and vigorously jerked with the hands. A very few such movements served to destroy nearly all the magnetism present, requiring the re-magnetisation of the ring.

As flexible iron rings such as I wanted were not easy to make, I procured some steel wire rope of the right size, and the ends were welded for me through the courtesy of Professor Elihu Thomson, of Lynn, by his electrical welding process. Such a ring, about a foot in diameter, allows a movement of five or six inches to one of its sides. This, when wound with four or five hundred turns of No. 22 wire may be magnetically saturated by sending a current through the wire, leaving the ring charged. The terminals may now be connected with a proper galvanometer, and changes in the form will discharge the ring.

These experiments prove:

1. That a change in the form of a magnet causes a corresponding change of stress in the field.
2. That periodic changes in form, due to elasticity of form such as are called sound vibrations, set up similar periodic changes or waves in the magnetic field.
3. That such sound vibrations of a magnet, act upon other magnets like sound vibrations and set them into corresponding vibratory movements, sympathetic or forced; sympathetic, when the receiving magnet has the same pitch as the transmitting magnet, and forced, when it has not the same pitch.
4. That such sound vibrations in the receiving magnet cause a corresponding change of form in its magnetic field, which manifests itself by electric currents in circuits surrounding it.

Sir William Thomson has frequently said that he could understand a mechanical idea when he could make a model of it, but could not otherwise. If one assumes that the ultimate atoms of iron are magnets, as is thought most probable now, or holds, by Ampère's hypothesis, that currents of electricity circulate about each one, making it a magnet—in either case, each individual atom has its own magnetic field, which is, necessarily, always with it. It is really its reaction upon the ether. If such atoms be elastic, as there are the best of reasons for believing, then it follows that impact must set them into periodic vibratory motion, that is periodic change of form at a rate depending upon their degree of density and elasticity. Such changes of form set up corresponding periodic waves in the ether, as changes in the magnetic field, and these are transmitted outwards, at a rate depending upon the properties of the ether to transmit such motions, and not upon the source of the disturbance.

Such vibratory motions among atoms and molecules we call heat, and such periodic waves in the ether, we call light, and thus Maxwell's idea of light being an electro-magnetic phenomenon is altogether in accordance with the experiments.

For waves of the lengths of light waves, it is essential that the vibrating body be small and highly elastic.

Maxwell's idea was that the opposite phases of ether waves could produce opposite electrical effects so that each half vibration represented either positive or negative conditions; and these implied, though I have not noticed the statement, that they must have originated with vibrating magnetic atoms or molecules. It has been difficult or impossible heretofore to imagine how ether waves could be set up by vibrations of the elements, though the idea that the atoms of matter are magnets is not new at all, and has a good degree of probability. If one is to picture to himself at all how this kind of phenomenon can occur, he is bound to have in mind some form for an atom that shall, at the same time, be a consistent magnetic form. If atoms are magnets, it is well nigh inconceivable that they should be spheres, or cubes, or tetrahedra, or discs, or any of the ordinary geometric forms, for such would be very poor forms to exhibit magnetic properties. But a ring presents a very different case, as a ring magnet is the most perfect form possible. There is this to be said of such a form, however; it does not present what *we commonly call* a magnetic field; it is a closed circuit. Nevertheless, I would ask if it is probable that the ether, external to a magnet of that form, should be quite unaffected, quite neutral? I should suppose not, but, on the contrary, should look for some sort of stress there, though it might be of a somewhat different nature, and have somewhat different properties from an ordinary magnetic field. But if such were the case, it follows that any magnetic change in the ring magnet itself, would be followed by a corresponding change in the external field, and vibrating motions would necessarily set up waves in that field. Such waves would have a magnetic origin, but the waves themselves would not necessarily give rise to electro-magnetic effects directly. Indirectly they would, for if they could make another similar magnet vibrate sympathetically, these vibrations would react upon its magnetic properties.

Such a ring form as I have shown, suggests at once the Vortex Ring theory of atoms, the properties of which I have so often spoken upon in this place. Perhaps the experiments should have a different interpretation from that suggested here, but whatever their interpretation may be, they are believed to be entirely new, and therefore of interest, if not important.

THE ELECTRIC ARC AND ITS USE IN LIGHTING.*

By ELIHU THOMSON.

(*Continued from page* 370.)

Before passing to the consideration of the running of arc lamps in series, or in multiple: and the condition to be fulfilled in each case, we may state that although in ordinary cases an arc is formed by a single pair of electrodes or carbons, and by a single circuit current, compound arcs, or arcs produced by combinations of two or more currents with three or more electrodes, are possible. I am not aware that any others than myself have experimented in this direction. I have, however, produced lights with two positives and one negative, with one positive carbon or crater and two, three, or more negatives, and with two positives and two negatives. I have caused arcs to cross each other, as when four carbons are used, pointing towards a centre, the two pairs opposite being respectively connected with different circuits. In this way direct arcs have been, as it were, mixed with alternating arcs and a curious compound effect produced by crossing two arcs made with two alternating currents the waves of which are displaced in phase. Without going fully into these experiments, I will present figures showing two good examples. Fig. 1 is formed by two currents sent into a positive, P, and dividing, after passing the crater, into two streams going to the two negatives. In this case the positive crater is fully exposed horizontally, and gives the most intense light in a direction forward. Such an arc is well adapted for projection by mirrors or lenses.

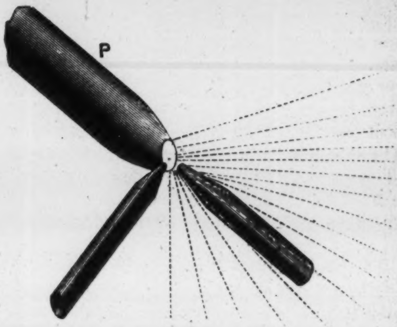


FIG. 1.—ARC FORMED BETWEEN ONE POSITIVE AND TWO NEGATIVE CARBONS.

Fig. 2 shows the arc formed by crossing two alternating currents out of phase. In this case there is at successive times an exchange of current between all four carbons in varying directions, so that the arc flame becomes, as it were, a ball or disc of very hot flame supported by the four carbons. These experiments have not been fully described as yet, owing to the lack of time, but they show very well that even when we have fully studied the single, simple arc, we will not then have exhausted the subject, as these compound arcs may be varied in character to a great extent, and present new effects.

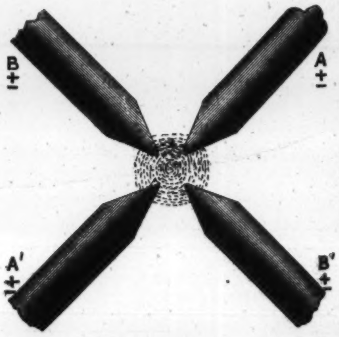


FIG. 2.—ARC FORMED BY CROSSING TWO ALTERNATING CURRENTS OUT OF PHASE.

In regard to that portion of our subject which concerns the use of the electric arc for lighting, it is true that there is a wide field before us. I cannot hope to do more in this paper than to outline, in addition to the considerations already alluded to, some of the other prominent features of the subject. It is well known that by far the larger proportion of electric arc lights in operation is run on circuits of constant current, the lights being in series.

If arc lamps be connected in parallel, as on low potential incandescent mains, special devices are required to keep the current supplied to each lamp at the right amount.

It may appear at first to one who has not had occasion to closely study these matters, that, given a constant potential circuit of 50 volts, arc lamps requiring 50 volts could be connected in multiple or parallel without difficulty. The fact is, however, that the condition of electric arcs being supplied with a constant potential involves a theoretical impossibility. Theoretically, such an arc would take an infinite current and energy. Practically, the current in an arc with constant potential becomes very heavy, and if the carbons be separated to cut the current down, as by a lamp magnet mechanism, a condition of fluctuation and instability results. This is a direct consequence of the fact before stated, that the resistance of an arc is not like a wire resistance, but falls with increase of current, and *vice versâ*. For stability the resistance should not be dependent wholly on the current passing. To remedy the instability, a resistance known as a "choking coil," or "sluggishing coil," is inserted in the arc branch, and the potential raised, say, to 65 or 70 volts. Under these conditions, that is with a resistance taking up 15 to 20 volts, in series with the arc, it may be run in multiple with incandescent lamps, or with other arcs. There is, however, a waste of energy equal to the product of the current strength by the loss of potential, 15 or 20 volts, in the resistance. A great deal of useless experimenting has been, and probably is yet, carried on with the vain endeavour of getting rid of the resistance or choking coil in this case, but the difficulty is inherent in the nature of the arc, the relation of resistance to current giving rise to instability of current in the arc.

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* Read before the National Electric Light Association, February 18th, 1891.

Similarly, not all dynamos, even if of sufficient potential, will run arc lamps in series. Arc machines require special properties, or the current will be unstable, and the light will fluctuate or "surge," as we sometimes call it, possibly to an extent amounting to extinction, and relightings occurring at short periods apart. This action, like the other, is dependent on the relation of current and resistance as inherent in electric arcs, and the series of lights would in each case require dead resistance up to a certain amount in circuit to render the current stable. Then, whether a series be operated or a single arc be operated, either a dead resistance must exist in circuit or the current-supplying apparatus must have special properties. The arcs produced from batteries were stable, because the resistance of the battery itself was sufficient to ensure this. Arcs are not stable as fed from accumulators of very low internal resistance unless the arc is one of enormous current.

Briefly, the property required to be possessed by an arc dynamo is that as its current rises above the normal, the electromotive force must fall, and as the current diminishes to a little below the normal, the electromotive force of the dynamo must rise. It is not sufficient to secure this changing E.M.F. by regulators, as they are generally behind time for causing stability of current, however well they may operate to regulate for varying numbers of arcs in the series to be supplied.

The properties of dynamos are sometimes expressed by what are called "characteristics," or "characteristic curves," obtained, for example, by laying off vertically, or on the ordinates, the electromotive forces corresponding to varying currents given out by a machine, which currents are laid off horizontally, or as abscissæ. In arc machines the curve so produced is convex upward, and droops at its outer end, *b*, fig. 3. Assuming normal current at 10 ampères and an E.M.F. of 500 volts, at 11 ampères the E.M.F. may have fallen to 420 volts and at 9 ampères risen to 530. We would then be working on the "droop" *a* to *b* of the curve when at 10 amperes; and such a machine is stable as to current for running arc lamps. There appears to be required not merely a droop in the curve, for securing stability, but more than a certain amount of rate of droop or dip. If the line could be made to droop or dip vertically after passing the normal current the machine would regulate without a regulator or be a constant current automatic machine.

In what respect, then, do arc dynamos differ from others to produce this relation of droop in the characteristic curve? Without doubt the effect is mostly due to the reactionary effects of the armature on the field, which effects in arc machines are made greater than in others, and the field magnets meanwhile are frequently saturated magnets, so called, and not greatly sensitive to the current in their coils. The armature of an arc machine is indeed so powerful an electro-magnet that it is able to control the magnetism of a portion of the field in which it turns. A sort of balance of magnetic forces is established at certain portions of the field which, on an increase of current in the armature, produces polarity opposing the field polarity at the portions mentioned, such as will cut off some of the lines of magnetism from entering the armature core and so lower the electromotive force; while a lessened current in the armature will weaken its polar portions and an increased number of lines will enter the armature core from the field and so increase the electromotive force at the brushes of the commutator.

Could the droop or fall in the characteristic curve be made a vertical, as stated before, then we should have a self-regulating machine not needing a regulator to preserve a constant current under all loads. This condition is more easily arrived at in alternating machines, one of the first, if not the very first, example of which is found in the Chertemps-Dandeu machine, which was tested by Robert Sabine, as described in Dredge's "Electric Illumination," vol. ii., 1885. This machine had the remarkable property of permitting 10 arc lamps to be cut out or put into its circuit in series in any way without causing a variation in current strength of more than 10 per cent. The interactions occurring between the armature and field accounted for this regulating property. In these cases the armature currents react upon the field with a force producing at times a balancing of magnetism between the two. The distortive power of the armature upon the field is made very great, which amounts to the same thing.

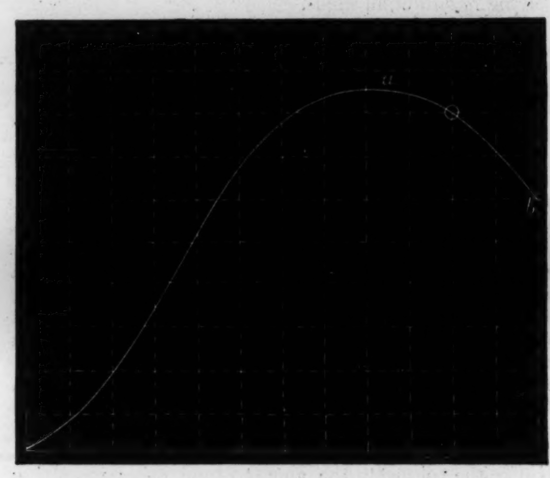

FIG. 3.—CHARACTERISTIC OF ARC LIGHT DYNAMO.

In the recent alternating machine for constant current, brought out by Mr. Wm. Stanley, we have an excellent example of the application of similar principles of construction, together with the difference that the arc lights which were fed direct in series from the Chertemps-Dandeu machine, are run from transformers with the primary coils in series in the Stanley apparatus.

The relation of current to constancy is, however, in continuous current dynamos for arc lighting, generally effected by regulators as they are called, which so alter the dynamo on a slight increase or decrease of current as to raise or lower its electromotive force according to the resistance in circuit or speed.

In one form of regulator the effect is obtained by changing the field magnetic strength by automatic mechanism weakening the field when lamps are cut out, and strengthening it when lamps are added to the circuit. Another means of regulation is the rotation of the commutator or brushes, so as to take current from positions corresponding to increased or decreased electromotive force in such a way that the current obtained is constant. The former method first appeared in the Brush arc apparatus and the automatic commutator brush movement in the Thomson-Houston machines. The latter method renders the machine completely automatic under variations of load, while in the former there still is required a manual spark adjustment of the brushes as the field magnet is altered in force under different loads. The two methods were subsequently combined by the writer in conjunction with Mr. E. W. Rice, jun., in such a way that the necessary brush adjustments were made automatically at the same time with the variations of the field under different loads. This combined method has been used for some time past in the Excelsior machines constructed under the patents and designs of Mr. Hochhausen, whose name is so well known in connection with arc lighting and plating and other electric apparatus in this country. On account of the fact that with the addition of arc lights in a series a higher and higher potential difference is required at the terminals of the dynamo, it becomes a question how far this increase may properly be carried. It is not unusual in the present practice to run from 50 to 60 lights in a series, each demanding from 45 to 50 volts, or a total of, say, 3,000. In going beyond this amount the difficulties of insulation are greatly increased, as well as the dangers of high potentials, while the consequent risk of breakdowns resulting from failure of insulation or leakage are often sufficient to offset any saving of wire conductor that might be obtained by running more lights in series. Instances have occurred in which with ordinary wiring and precautions, 120 to 150 arcs have been run for days together, but such a practice is to be condemned as involving hazard of all kinds.

(*To be continued.*)

PRACTICAL PHOTOMETRIC RESEARCH.

By RALPH CONRAD RICHARDS.

PART II.

IN the last section of this paper,* the author described at some length those points which it seemed to him required the most elucidation; stress was therein laid upon the necessity for minimising the contraction of the iris, and an attempt was made to show how this problem might be dealt with in practice.

In this section are given the various details concerning an instrument which it is contended is in every way well suited for carrying out scientific photometry, in which case accuracy is desirable.

Unlike the voltmeter, the ammeter, and other measuring instruments with which the practical electrician or the physicist has to deal, the photometer neither possesses nor can ever possess what would, in the strictest sense of the term, be styled an absolute character.

Light is, physiologically speaking, a sensation which affects the optic nerve; we are therefore only capable of estimating the luminous emission from any light source by the physiological effect produced.

New photometers are devised from time to time, the majority being modifications of the older forms; if, however, the law which proclaims the survival of the fittest be feasible (and experience seems to incline towards this belief), the type due to Bunsen is yet predominant.

The various improvements which light standards have undergone at the hands of various inventors, notably, by H. Vernon Harcourt,† have been of material assistance towards the solution of the problem, yet much room is still left for improvement, even in this direction.

Coming next to the question of automatic photometers, a great deal is to be said on this head. Siemens appears to have been the first to work practically in this direction, the Siemens's selenium photometer being the outcome of his ideas on the subject; unfortunately, however, two very grave chances of error prevent the advantages which the electro-optic properties of selenium seem to offer from being utilised; firstly, the opposed resistance is not constant for any protracted period, owing probably to the occurrence of a molecular change, due to the strain sustained when the molecules are forced into a direction varying from the normal; and secondly, to a further temporary change, dependent upon the E.M.F. of the battery employed in conjunction with the cell. It is unnecessary to state that the former of the above-mentioned possible sources of error would entirely prevent the adoption of this substance.

Prof. Minchin recently exhibited some cells, exhibiting great ingenuity of design, which seem to possess a great range of action, although in the absence of any data, it is impossible to state whether the indispensable quality of constancy is also possessed by them. Among other forms deserving of mention is an iodide of nitrogen photometer, depending upon chemical action; the effect of which is to liberate a certain quantity of gas; this form seems to be cumbrous and liable to derangement. Mr. E. Merritt, of the Cornell University, used the thermopile with success in arc lamp determinations. It is, however, certain that this method is inapplicable where it is desired to compare lights differing in spectral composition, unless modified; for the amount of heat developed on the impingement of light rays upon a solid substance is not proportionate to their luminosity; this may be readily proved, on a rough scale, by exploring the area exposed by the incidental spectrum of white light with a thermopile, when it will be observed that the thermo-electric effect produced commences from just beyond the visible red extremity, gradually becoming less, until when the violet portion is reached the effect will have become practically nil; the visual effect, on the contrary, has its maximum effect in the yellow portion, merging into nullity towards both extremities.

The writer devised an instrument on this principle (but having modifications added) some time back; but was compelled to abandon his design on account of the great liability to error which such an instrument entails.

Mr. Crookes recommended the application of his radiometer, and an instrument has actually been devised, acting upon this principle, in which the effect produced is indicated by the torsion imparted to a fine thread from which the vane is suspended; this is certainly beautifully simple, and, could it be applied to compare accurately, lights differing in spectral composition, would indeed be peerless in design; facts, however. seem to point to the impossibility of this.

The instrument with which the present article is concerned cannot, it is true, be said to have been designed upon new principles, inasmuch as the various parts are individually founded upon old and well authenticated facts; but the agglomeration of these into the principle of a single instrument forms an apparatus, possessing novelty equally with many forms, founded upon principles which the inventors have themselves laid bare.

Although it is far from the purpose of the present article to institute a comparison between the various types in existence, yet it should be stated that, in the writer's opinion, he would not be justified in taking this opportunity of bringing his instrument before the electrical profession, did he not consider it to be so perfect as to require little or no improvement regarding its correctness.

Conditions which an Automatic Photometer should fulfil.

Whatever be its ultimate form, it is of primary importance that an instrument designed to measure the luminous effect produced upon the eye by any light ray should be calibrated by aid of that organ, for it is obvious, even upon the assumption that a substance possessing physical properties in accordance with those of the human eye were in existence, the very truth of this fact could only be verified by reference to the organ of vision.

As a matter of fact, however, no such substance exists, and if by some device the physicist is enabled to alter at will the effect produced upon a certain instrument (making it correspond exactly in any part of the spectral band with the proper proportionate optical effect), it is only by a calibration carried out as before-mentioned that he would be enabled to complete his apparatus.

Another condition which seems to have been but slightly observed in any instrument yet constructed is the capability of measuring in a rational manner *all* the useful luminous emanation.

Incandescent lamp measurement as at present conducted takes into cognisance only the front horizontal emission, it being imagined that in the case of filaments similarly shaped the radiation will, speaking geometrically, be uniform; thus with two similarly-shaped filaments, the size of one being expressed as unity, and its light emission frontal-horizontally also as unity, the other filament being in both respects of a magnitude = 10. It is considered that the side emission of the two filaments will be as 1 to 10; this will be the case, approximately speaking, but it must be remembered that the sectional form is a great factor in the decision of this question.

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* ELECTRICAL REVIEW for January 30th

† Pentane burner.

Arc lamp photometry is conducted under circumstances offering a still greater liability to error, and the exploration method usually adopted leaves much to be desired.

It is, however, obvious that no modification of the Bunsen photometer, nor, in fact, of any other instrument in existence, would assist in the solution of this problem, unless the design became even more unwieldly than is at present the case. The correct comparison of light sources differing in spectral composition is another point to be solved, whilst any means whereby the apparatus could be rendered more compact, at the same time enabling measurements to be conducted independently of external illumination, thus dispensing with the necessity of working in a darkened room would be great desiderati.

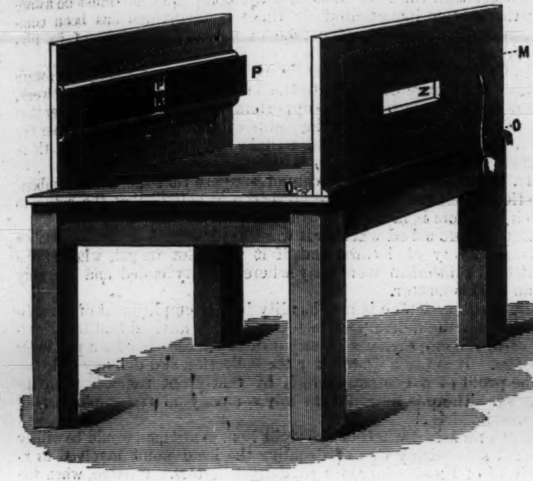

FIG. 1.

The first necessary operation is to obtain a correct knowlege of the luminous properties of any part of the spectrum, and this is most conveniently effected by means of an apparatus illustrated in the annexed cut. It consists of a rectangular table, on the two opposite sides of which are fitted wooden screens, J and M.

The screen, J, is covered with white card; a lantern (not shown in the sketch) projects a well dispersed spectrum, B, by means of a flint-glass prism. A mirror is so arranged as to project a band of white light, P′, similar in proportions to, and one inch above the spectrum, B.

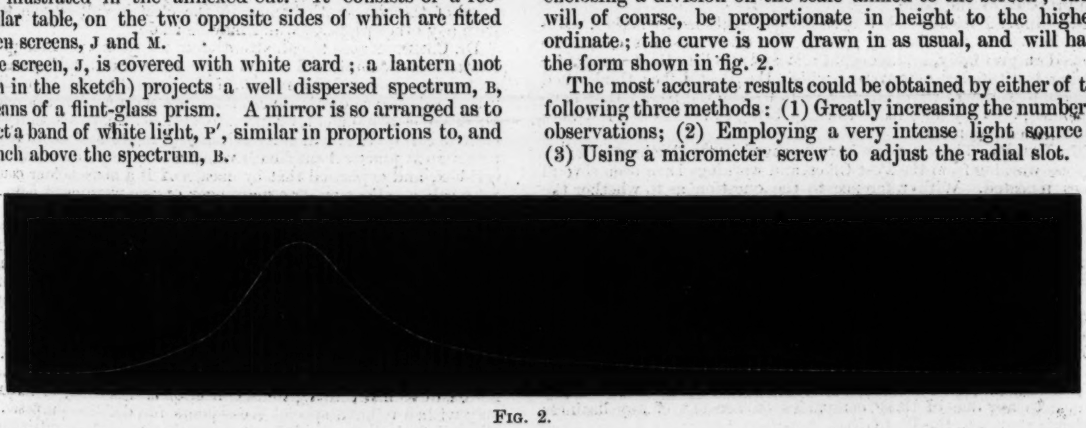

FIG. 2.

Having projected the spectrum upon the screen, a line, K′, is drawn from either extremity of its luminous extent, and carefully divided into 100 equal parts.

Two pieces of wood, grooved on one side, are fixed horizontally, and at such a distance apart upon the screen, J, as to just clear the spectrum and white strip, P′, and into either end of these grooves slide two cards, P and K, coated with a very intense, non-reflective black pigment.

Provision is thus made, whereby any small portion of the spectrum between two marks of the scale and a corresponding strip of white is capable of being exhibited; this is attainable on sliding the two black cards until all but the desired area is hidden from view, since the cards are practically perfectly non-reflective.

It is of importance that the observer always occupy the same position relatively to the two illuminated strips; hence the screen, M, which is furnished with a small aperture, Z, at a convenient elevation, is arranged to slide in a groove, O, on the surface of the table.

A large disc, which is capable of revolving at a high speed, is arranged on the radial slot principle; this is caused to intercept the beam of light causing the white strip, thus affording means for effecting any required reduction in its luminous power. A snap shutter is mounted on the optical stage of the lantern, the pneumatic ball of which is under the control of the observer seated before the slot. By this means an instantaneous view of the two strips is afforded, and, owing to the fact that the exposure is very rapid, the involuntary faculties are far more occupied in comparing the absolute ratio of brilliancy existing between the two strips, *i.e.* (the spectral and white strips), than by taking a mental survey of their colour, for it is a well known fact that the length of time occupied by the functions of the optic nerve coming into play after the cessation of illumination is slightly dependent upon the brilliancy, although the average effect is about ·1 second. The method of procedure is very simple, the observer arranges the cards to exhibit any one of the scale divisions. Then seating himself behind the aperture, he presses the ball; an instantaneous view is then given of a strip of white band and an equal portion of the spectrum; the white will appear more brilliant. The radial slot is then adjusted and the operation repeated, until both strips appear equally illuminated. The same procedure is now gone through with the remaining divisions, the slot width of the revolving wheel necessary to obtain adjustment being noted in every case. This should be repeated with at least nine other observers, all of whom it it unnecessary to state must have good average sight, and be free from colour blindness. We have then 10 observations for every division throughout the scale, and when the operation is repeated twice with each person, we shall possess 30 separate observations for each division, from which an average is taken in each case of the slot width required. By expressing this as a ratio, and so determining the illuminative power in each case, the experimenter is enabled to plot out a curve indicating the luminosity of all the rays throughout the spectrum; the space enclosed within this curve will then illustrate the total luminous power of the whole spectrum.

The manner in which this is accomplished is to take the scale and to raise ordinates from between any two marks enclosing a division on the scale affixed to the screen; these will, of course, be proportionate in height to the highest ordinate; the curve is now drawn in as usual, and will have the form shown in fig. 2.

The most accurate results could be obtained by either of the following three methods: (1) Greatly increasing the number of observations; (2) Employing a very intense light source;* (3) Using a micrometer screw to adjust the radial slot. A combination of these three methods (in each case under the most favourable circumstances), would give, of course, very accurate results. The next consideration refers to the principle on which the instrument in question depends.

(*To be continued.*)

Lighting at St. Immer.—This small Swiss Town, of 8,000 inhabitants, is to be provided with new water and electricity works. The current will be generated by dynamos driven by turbines from the Bez source, eight miles from St. Immer. A charge of 11 francs per 10-C.P. lamp per annum has been fixed, whilst the price of gas is 25 francs for a jet burning 800 hours annually.

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* This would enable observations to be conducted throughout those parts not visible with a lesser illuminative power.

PARLIAMENTARY NOTES.

THE Select Committee of the House of Commons on the Bill, promoted by the London County Council, providing for the control and regulation of overhead wires by that body, met again on Wednesday, Mr. S. Williamson in the chair. The arguments were concluded on Tuesday, but owing to the late hour the committee decided to reserve their decision until Wednesday. Upon counsel being called into the room, the chairman said the committee had come to the conclusion that the preamble of the Bill had been proved, and were of opinion that the distance of 50 feet should stand part of the Bill. They were of opinion that the Inns of Court should not be exempt, and all reference to subways should be struck out; that all reference to the supervision of wires should be omitted, and also the rights of entry. The committee decided that the provision for charge for supervision and wires be omitted from the Bill, and struck out no less than six entire clauses, while in others they made some unimportant amendments. The Bill then passed the committee, which fact was ordered to be reported.

THE MESSENGERS COMPANY AND THE NEW POSTAL SYSTEM.

In the House of Commons, on Thursday night,

Mr. Cobb asked the Postmaster-General whether, under the new postal system announced in the morning papers of last Saturday, the Post Office proposed to exclusively work the call system, or whether it was proposed that this system should be worked by companies or persons under licenses from the Post Office.

Viscount Grimston asked the Postmaster-General "if he was prepared to fix electric calls in the houses of such persons as may desire the same, without charge, as the District Messengers' Company have done and are now doing, and to supply messengers to run errands and make small purchases, carry notes and parcels, call cabs, policemen in case of burglary, fire engines in case of fire, &c.; and, if not, if he will consider favourably the petition of the said company to carry on their business under a royalty to the Post Office, before depriving the public of this great and much appreciated convenience."

Mr. Raikes: In reply to the hon. gentleman opposite, I have to say that it is not proposed to grant licenses for the electric call system, and the Post Office will be prepared itself to meet the demands of the public in this matter. In reply to my noble friend, I have to say that the Post Office will be prepared to supply electric call apparatus, but that a charge must necessarily be made for it. I do not suppose that the District Messengers' Company could have had the intention of providing any such gratuitous service to the public as the noble lord suggests, although it is not impossible that temporary advantages of this sort might have been offered to a few persons of influence. The business of the department is to deliver letters, telegrams, and parcels, and I have no wish to interfere with any branch of the District Messenger service which does not infringe upon the province of the State.

Mr. Cobb: I wish to ask the right hon. gentleman whether, without a license to use the call system, the other business cannot be carried on profitably, or, indeed, at all; and whether these companies having instituted a new system which the Post Office think good enough to follow, they ought to be left to lose the money they have expended, the only offer made to them being to take over a few boys into their employment.

Mr. Raikes: The company have engaged in this business after an express warning from the Post Office, and warnings have been several times repeated. With reference to the question as to whether the system of electric lighting call might be applied to other business than that which comes within the province of the Post Office, I should be very glad to consider what course the department would adopt in regard to that.

Mr. Cobb: Will the right hon. gentleman, in making any arrangement, also consider whether the District Messenger Company are at present working the call system under the promise of a license, and that the other has applied for a similar license?

Mr. Raikes: I am prepared to take into consideration any portion of the company's business which is outside that which is within the jurisdiction of the Post Office. There has been no promise of any license to any one of these companies on account of any business which is proper to the Post Office.

Dr. Cameron: What is that part of the business proper to the Post Office?

Mr. Raikes: I have just answered that question. The business of the department is to deliver parcels, letters, and telegrams.

Dr. Cameron: I beg to give notice that I shall raise the whole matter on going into Committee of Supply.

Viscount Grimston: Is the right hon. gentleman aware that the effect of abolishing the powers of these companies to carry parcels and letters will be to deprive them of so much of their possible revenue that the remainder of the business will not pay, and the service will, therefore, be lost to the public?

Mr. Raikes: I do not know what would be remunerative business, but my business is to give effect to the law.

BRENNAN TORPEDOES AND THE DYNAMITE GUN.

In the House of Commons on Monday Admiral Mayne asked the Secretary of State for War whether he would stop the further manufacture of Brennan torpedoes pending the completion of the experiments with the dynamite gun, which it was believed by many did all that the Brennan torpedo could do, and probably much more, and was not open to many of the objections to the Brennan.

Mr. E. Stanhope: I should have thought that my hon. and gallant friend would have been aware that the dynamite gun differs so essentially from the Brennan torpedo that the weapons cannot be compared, and it is improbable that the adoption of the former, should it occur, would justify the neglect of the latter means of defence. A naval officer, detailed for the purpose, advised as to, and concurred in, the sites selected for the Brennan torpedo stations.

THE POST OFFICE AND THE MESSENGER COMPANIES.

Mr. Cobb asked the Postmaster-General on Monday night whether the Boy Messengers' and the District Messengers' Companies could be allowed to carry out and to reap the benefit of the system which their labour and capital inaugurated, and whether he would, with that view, grant them licenses to work the electric call system upon payment of a royalty to the Post Office; and whether, if it should be legally necessary, he would introduce a short Bill to authorise charging a royalty.

Mr. Raikes: It is my first duty to vindicate the rights of the State in the courts of law if necessary. After this has been done I am quite willing to consider any suggestion that may be made in the interest of public convenience, so far as they can be reconciled with the law. If the hon. member has read the correspondence which has passed between the Post Office and the companies he must be aware that the system inaugurated by these undertakings has been commenced and carried on in the face of repeated warnings of its illegality.

Dr. Cameron asked whether the right. hon. gentleman was aware that the Patronage Secretary to the Treasury sent, five times a week, letters to the Government's supporters by messenger; whether that was not an infringement of the rights of the State; and whether the right. hon. gentleman proposed to take any steps to vindicate those rights?

Mr. Raikes: Of course I cannot suppose that the hon. members' question is serious, but I have no reason to believe that the action to which he refers is in any way illegal.

Lord Elcho asked whether it was illegal to employ commissionaires in the delivery of letters, and, if it were not illegal, whether the right hon. gentleman would say where legality ended and illegality began in this matter.

Mr. Raikes: There is no illegality in the employment of commissionaires for the delivery of letters. We are advised that it is equivalent to the employment of any ordinary messenger for a particular message. It is not a system for the collection and delivery of letters to the profit of a company which by that profit trenches upon the revenue. There is no profit to any company in the employment of commissionaires.

Mr. Cobb asked whether the right hon. gentleman would be willing to grant some ready way of deciding the legal point involved as to the right of these companies to deliver letters. Further, when the point was decided, would the hon. gentleman be willing to grant licenses to the messenger companies for the use of the electric call system?

Mr. Raikes: It is my intention to have the legal point decided almost immediately. An information will be filed before the Easter holidays, and the case will be heard as soon as the Courts reassemble. When a decision is given, I shall be in a position to consider the proposal of the hon. gentleman as to the electric call system, together with any other proposal which may be made.

Dr. Cameron rose to call attention to the position taken up by the Postmaster-General with regard to the electric call and boy messenger system, and would have moved, if the orders would have allowed: "That this House disapproves of the Postmaster-General's refusal to allow the establishment by private agencies in this country of the electric call system, which American experience has shown to constitute a great practical public convenience." He produced an electric call-box, and explained that by means of it a householder could call for a cab, a policeman, or a messenger, or give warning of a fire. The Postmaster-General regarded this service as an infringement of the rights of the State, and he proposed to institute a similar service. In this the right hon. gentleman was going backwards, for in 1886, when a proposal was made to start such a company, he offered to grant it a licence for a royalty of 2s. 6d. per subscriber, and one of £20 on the operations of the company. At first it was proposed to establish communication by telephone, but now that the electric call was introduced, the Postmaster-General said it was an infringement of the monopoly of the Post Office. The telephone company denied that contention, and said that they did not desire to institute a general collection and delivery of letters, but only wished to have special messengers for definite purposes. The Electric Call Company did not deny that they were infringing the postal monopoly, and recognised that they could carry on the business only by license of the Postmaster-General. The second company was quite willing to admit the claim of the Postmaster-General to the exclusive right of the Post Office to carry letters, and had offered to pay them a royalty of 1d. for every letter they carried. The Postmaster-General had said that he intended to set up an alternative system, and to keep a number of messengers at each post office, who were to carry express letters and parcels between 8 in the morning and 7 at night. Many people, however, lived at some distance from a post office, and, moreover, the duty of the Post Office messengers would be limited to carrying letters or parcels, whereas the company offered to place electric call-boxes in the house of any one who wished for one, to keep their boys on duty day and night, to take luggage to and from railway stations, to bring dress clothes to clubs, to deliver messages to tradesmen, to get doctors' prescriptions made up, to fetch parcels from the stores, to get cheques cashed, to get books from libraries, to take dogs for a run, to clean windows and boots, and to do many other things. They further undertook to send cabs, fire engines and policemen. He had read a long article in the *Times* of that morning which contained the defence of the system proposed to be established by the Postmaster-General, and a weaker case he had never read. The Postmaster-General appeared to be afraid that these companies would cut down the public revenue, which was derived from the Post Office; but that fear could not be well founded, seeing that the companies offered to pay a royalty of 1d. for each letter they carried. The offer of the Postmaster-General to take over the staff of the companies was scarcely fair to the companies. For a quarter of a franc one got a card sent at once by express pneumatic tube, and for half a franc a letter. That was what the right hon. gentleman ought to do for us. What the right hon. gentleman proposed to do—namely, to refer the matter to legal arbitration—was quite beside the question, and his action might be characterised as it had been in various quarters, as nothing better than dog-in-the-manger action.

Mr. RAIKES said that the lateness of the hour must prevent him from giving a detailed answer to the objections which the hon. gentleman had taken to his conduct in this matter, and as he hoped in a short time to obtain the decision of a court of law upon the main issues it would be premature to discuss that evening what course he might be obliged to take after that decision had been obtained. The hon. member had very seriously misapprehended the action of the department. The main question was one not between the Government and the District Messengers' Company, but between the Government and the Boy Messenger Company, which was simply an express service by means of boy messengers. The new service, of which the particulars appeared on paper to-day, would be a far more efficient service. He would merely point out that the number of stations would be at least double that of the Boy Messenger Company, and the number of boys employed ten times as numerous; the charge would be less, and, in fact, the new system would have every advantage which one system could have over another. He would only say that he should be glad indeed, if he could believe he had no responsibility in this matter, but having before him the opinion of competent advisers, based upon Acts of Parliament, he was bound to believe, that he should have, so far, a regard to the public interest that he must defend it against speculators whom he could not allow to carry on a business which he believed was an invasion of the rights of the State. Having obtained the decision of a court of law, he would be prepared to consider any proposal that might be made for utilising either of those schemes. He had been for a long time endeavouring to devise some such scheme which he might dovetail with a department of the State, but until he obtained the assent of the Treasury to create a substitute service he felt himself justified in taking action as to which, if he had taken it at an earlier period, he might have deserved the epithets the hon. gentleman had applied to him. His desire was that the public did not suffer from any action the Government had undertaken, but he was forced to act as he had done, because he was served a fortnight ago by one of the clients of the hon. gentleman with a mandamus to compel him to take action in the case. It was out of pure charity that he wished to utilise the boys in the service of the companies. He was sorry that the companies had refused, but the public would not suffer, because he was in a position to offer more efficient service. He was perfectly ready to consider any scheme which the public might expect advantage from as soon as he should establish the right of the Post Office to exercise those privileges which were conferred upon it, not by him, but by many Acts of Parliament, the last of which was an act passed in the first year of the reign of our present Sovereign.

Mr. CONYBEARE admitted that it might be desirable that the decision of a court of law should be obtained as to the legal aspect of the matter, but he took leave to observe that there was a great deal more to be said on the general question as to the convenience of the public at large.

It being 12 o'clock, the debate stood adjourned.

LONDON COUNTY COUNCIL.

NOTICES UNDER ELECTRIC LIGHTING ORDERS AND ACTS.

AT the weekly meeting, the Highways Committee reported as follows: We have considered a notice (Registered No. 168), dated 25th February, 1891, from the Metropolitan Electric Supply Company, of intention to lay mains in North Wharf Road, Harrow Road, Dudley Street, Hermitage Street, Church Place, St. Mary's Square and Terrace, Porteous Road, Fulham Place, Hawley Place, Maida Hill west, Blomfield Road, Warwick Road and Crescent, Delamere Terrace, Street and Crescent, Clifton Villas, Westbourne Terrace Road, Blomfield Crescent and Street, Upper Westbourne Terrace, Westbourne Bridge and Square, Chichester Road, Place and Street, Ranelagh Road, Cottage Road, St. Germain's Terrace, Gloucester Crescent and Gardens, Bishop's Road, Sheldon Street, James Street, Eastbourne Terrace, Orsett Place and Terrace, Porchester Square, Westbourne Park Terrace, Pickering Terrace, and Albert Terrace. The proposed works appear to be unobjectionable, and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 168), dated 25th February, 1891, of the Metropolitan Electric Supply Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the works in any of the thoroughfares specified in the notice; that the mains be inclosed in iron pipe or efficient casing, and be laid under the footways wherever it is found practicable to do so; that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, insulated from each other as far as practicable; and that the outer cover, which shall consist of an iron frame filled in with material to suit the paving, shall be efficiently connected to earth.

The undermentioned notices from the London Electric Supply Corporation have also been considered by us—

27th February, 1891, of intention to lay distributing mains on west side of Deptford High Street (amended).

27th February, 1891, of intention to lay distributing mains in Stratton Street, Piccadilly.

7th March, 1891, of intention to lay distributing mains in Borough High Street, Duke Street, and Tooley Street.

10th March, 1891, of intention to lay distributing mains in Arlington Street and Bennett Street.

18th February, 1891, received 14th March, of intention to lay distributing mains in Chesterfield Gardens.

The works referred to in these notices are of the same character as those of the same company previously sanctioned by the council, and we recommend that the sanction of the council be given to the works referred to in the five notices (Registered Nos. 169 to 173, both inclusive), dated 27th February (2) 7th and 10th March, and 18th February, 1891, respectively, of the London Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing any of the works; that the mains be laid under the footways, and be kept 9 inches below the under side of the paving wherever it is found practicable to do so; that where the mains cross the carriage-ways they be kept at the same depth below the concrete or the road material as the case may be; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from the other as far as practicable, and that the outer cover shall be efficiently connected to earth.

We have also to report the receipt of the notices from the same company, given in accordance with the resolution of the council of 16th December last, to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid.

We have considered two notices, dated 26th February, and 16th March, 1891, respectively, from the Kensington and Knightsbridge Electric Lighting Company, of proposed extension of mains in Hill Street, Stamford Road, Eldon Road, and Victoria Road. The proposed works are of the usual description, and we recommend that the sanction of the council be given to the works referred to in the two notices (Registered Nos. 174 and 175), dated 26th February and 16th March, 1891, respectively, of the Kensington and Knightsbridge Electric Lighting Company.

The St. James and Pall Mall Electric Lighting Company has given a notice dated 3rd March, 1891, of intention to lay mains in Regent Street, Beak Street, Vigo Street, Haymarket, and Coventry Street (1 plan). There appears to be no objection to these works; and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 176), dated 3rd March, 1891, of the St. James and Pall Mall Electric Lighting Company.

A notice, dated 12th March, 1891, has been received from the Notting Hill Lighting Company, of intention to lay mains across High Street, Notting Hill Gate, from Linden Gardens to the Mall (1 plan). The proposed works are unobjectionable; and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 177), dated 12th March, 1891, of the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the coverstones of the culvert shall be not less than 2 inches thick; that where the culvert crosses the carriageway there shall be at least 9 inches' thickness of Portland cement concrete above the cover stones of the culvert, in addition to the road material; that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from the other as far as practicable, and that the outer cover shall be efficiently connected to earth.

We have considered a notice dated 28th February, 1891, from the House to House Electric Lighting Company, of intention to lay mains in Astwood Road (one plan). There appears to be no objection to what is proposed; and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 178), dated 28th February, 1891, of the House to House Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that no pipes of a larger diameter than 6 inches shall be used; that the mains shall be laid under the footways wherever it is found practicable to do so; that the street boxes to be used shall be of the pattern approved by the council; and that, as an additional precaution against accident through defective insulation of the mains, each of the street boxes shall be provided with an inner as well as an outer cover, each insulated from the other as far as practicable, and that the outer cover shall be efficiently connected with earth.

The Westminster Electric Supply Corporation has given notice (Registered No. 179), dated 10th March, 1891, of intention to lay mains in Derby Street, Pitt's Head Mews, Seamore Place, Duke Street, Robert Street, South Moltan Lane, St. Margaret Street, Arabella Row, Ambrosden Avenue, Carlisle Place, Francis Street, Abingdon Street, Belgrave Square, Chester Street and Place, Chesham Street and Place, Dean's Yard, Eaton Terrace, Grosvenor place and Crescent, Halkin Street and Place, Little Smith Street, Lyall Street and Place, Lowndes Place, Marsham Street, Motcombe Street, Old Palace Yard, Poet's Corner, South Eaton Place, West Eaton Place, Wilton Street, Place, and Crescent, Knightsbridge Road, Ebury Square, Flask Lane, and Bessborough Place (12 plans). The proposed works will extend over a large area, but there seems to be nothing to which objection need be taken. We recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 179), dated 10th March, 1891, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work in any of the streets referred to in the notice; that the mains be laid under the footways wherever it is found practicable to do so; and that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving.

Electric Testing Station.

We reported, on 17th April last, that the tender of Mr. W. Buckeridge, jun., for the execution of the works of alteration and repair necessary to adapt the premises, Nos. 42 and 43, Cranbourne Street, for the purposes of the electric testing station, for the sum of £694, had been accepted. The works have now been completed, and it appears that, owing to extra works not provided for in the contract, the contract price has been exceeded by the sum of £55. We recommend that, subject to an estimate being submitted to the Finance Committee as required by the statute, the additional expenditure of £55 above referred to be sanctioned.

Subways—National Telephone Company.

We have had a letter before us from the National Telephone Company, asking for permission to use a space having a sectional area equal to one square foot in the council's subways in Queen Victoria Street and the Victoria Embankment, to be occupied by the company's cables, and offering to pay to the council a rent of £100 a year in respect of the space so occupied. We recommend (*a*) that the offer of the National Telephone Company be accepted, subject to the condition that the positions to be occupied by the company's cables in the subways be approved by the chief engineer of the council; that all cables and wires of the company now in the subway shall be removed into the space specified, and that all work connected with the subway shall be carried out under his supervision and to his satisfaction, and at the cost of the company; and that proper earth connections be provided for the lead-covered cables. (*b*) That the solicitor do prepare an agreement with the company to give effect to the arrangement.

REVIEW.

Decorative Electricity. By Mrs. J. E. H. Gordon, with a chapter on Fire Risks by J. E. H. Gordon, B.A., M.I.C.E. Illustrated by Herbert Fell. London: Sampson Low, Marston, Searle and Rivington, Limited, 1891.

The title given to this book is decidedly a misnomer. In place of Decorative Electricity, the more appropriate name would have been "A few Chapters from the Autobiography of Mr. and Mrs. J. E. H. Gordon," which any reader of the work will find to be in accordance with the matter, and not at variance with the fashion of the day. From the preface, we learn that part of the book has been published in the *Fortnightly Review*, which, with the permission of the editor, is reproduced, together with practical details to assist any one wishing to instal the electric light in his house.

The first chapter is devoted to warning would-be installers against "plumber electricians" (classed with jerry builders), whose sole aim in life is *extras*, and advising the public to employ none but first-class firms who have reputations to lose, and who have given years of attention to the subject. There is a recommendation to have a separate meter to supply the servants' portion of the house, as tending to economy; there are also many useful hints respecting the position of switches, sockets, &c. We must, however, take exception to the statement that "the cost per lamp per hour is about 20 per cent. more than gas; but owing to the far greater facilities for switching off the electric light when it is not wanted, when gas would have to be left burning, the cost per lamp is with ordinary care practically less than gas."

Electricity costs about a farthing per hour for an 8-candle lamp (unit at 8d.) plus wear and tear of lamps, an item not to be overlooked. Gas at 3s. 4d. per 1,000 feet will cost per 8-candle burner, consuming 2½ feet to produce that amount of light, ·4 of a farthing plus wear and tear of burner, which is practically *nil*. Cost of electric lamp 150 per cent. more than gas for the same quantity of light furnished, otherwise in the ratio of 5 to 2.

But the authoress says that in calculating the expenses of electric light, they should not be compared with the former gas bills only, but with the gas, paraffin, and candles, with a small sum added for tapers and matches. Very well; let us do so, and compare the cost for lighting a small house by the old methods with the cost of the equivalent in electric light. The figures appended are from an actual example sent to us, and relate to the lighting of a house for the past quarter (85 days). Fogs and general darkness the prevailing weather:—Gas lights in kitchens and offices, 8 in number, average light of each 12 candles; paraffin lamps in sitting rooms and bedrooms, 1 duplex of 30 candles, four 12-candle lamps, and occasionally one or two small lamps; candles used in bed rooms.

The number of hours during which the lights were burning was as follows;—Gas lights averaged 7 hours per day, or a total for the 85 days of 595 hours, at a candle power of 96; paraffin lamps averaged 6 hours per day, or 510 hours, at a candle power of 78; candles, 180 in number, about 1,260 hours, at 1 candle power. The gross total of light produced was equal to 12,270 hours at 8 candle power.

The cost for gas for 15,400 feet was ...	£2	11	4
" " paraffin, 24 gallons ...	1	4	0
" " candles, 30 lbs.	0	15	0
Total cost of old method	£4	10	4

To produce the same amount of light by electricity, 12,270 hours at ¼d. per hour, the cost would be just over £12 15s.; or, in other words, the electric lighting would exceed the ordinary mixed lighting by 180 per cent., or in a ratio of 2·8 to 1, a vast difference from the stated 20 per cent. enhancement.

Chapter II., on "Fire Risks of Electric Lighting," is written by Mr. J. E. H. Gordon, who will not much increase his reputation thereby. The chapter is full of trite information on fuses, glow lamps, and wire, deprecation of small firms, exaltation of the inspection from a *responsible* fire insurance officer, who should always be consulted in regard to the quality of insulation of wires. In "Westinghouse" fashion, he minimises the fearful accidents in America through electric lighting by saying that a workman or linesman owning a defective watch does so at the risk of his life, (the custom in the States being to stop the high-pressure current in a wire about to be repaired until a stated time, when it is turned on again), and instances a case where a man mounted a pole some time after the current had been switched on, scraped off the insulation, and, on attempting to cut the wire, fell dead. Mr. Gordon adds, it is needless to say how much the case was exaggerated. This case is apparently picked out as a fair example of American accidents, but if our memory does not play us false the majority of the unfortunate victims to high-pressure currents were killed by touching wires which were supposed to be harmless, and from no imprudence of their own.

The portion of the book devoted to decorative electricity is evidently written from personal experience, and will be read with interest by ladies who are thinking of adopting the electric light. We are sceptical as to the pretended economy, though, and think that electricity and gas stoves are on a par in that respect. There is a recorded case of a gas stove being worked in a private house with a consumption of gas not exceeding that published by the gas company, so it is not impossible, with great care, to run an installation of electric lighting satisfactorily in an economical sense, but it will be a *rara avis*.

Mr. Gordon will, when electric light becomes more prevalent, be looked upon by the fair sex as a benefactor of their kind, for he describes a bed and reading lamp which is arranged with a second lamp, used as a resistance only, and enclosed in a box under the bed. A three-way switch breaks the circuit, puts the lamps in series for half light, or by a third position short circuits the resistance lamp and gives full light. How convenient the series arrangement will be for those ladies who nightly look under the bed for a cat!

As a practical work, the omission of the last or autobiographical chapter, and the chapter on fire risks, would add to its value.

On closing the book we notice several advertisements by well-known firms of electrical engineers and makers of fittings, who seem to be the manufacturers of most of the articles described in the text. This opens out a doubt in our mind whether we were justified in calling the book an autobiography, and whether the more correct name would not have been a trade catalogue disguised by autobiographical sketches.

NOTES.

Electric Light in Hampstead.—Mr. Preece, in submitting a report on electric lighting of the district, suggests that the vestry undertake the work, at an estimated cost of £80,000.

Electric Traction at Greenwich.—We understand that Messrs. Merryweather and Sons have carried out certain experiments in electric traction at Greenwich. According to accounts, the system is similar to the one employed by Lineff.

Telephone between Berlin and Vienna. — It is rumoured that preparations are being made to erect a telephone line between Berlin and Vienna.

Telegraph Materials.—The Lancashire and Yorkshire Railway Company requires signal and telegraph fittings and wires, &c. Forms of application for tender may be obtained from the stores department, Osborne Street, Manchester.

The Electrical Engineers' Vade Mecum.—This little book, by Mr. Browett, of Browett, Lindley & Co., Limited, will be found useful and handy. One great advantage in it is that it does away entirely with nominal horse-power, and the arrangement is very neat and good for reference. It will be found especially useful for electrical engineers who do not know much about engines, &c.

The Dominion Telegraph Company.—In the report of the Dominion (of Canada) Telegraph Company, Limited, presented to the annual meeting, it was stated that the quarterly dividends at the rate of 6 per cent. per annum guaranteed by the lessees, the Western Union Telegraph Company, have been duly paid as well as the interest semi-annually of 6 per cent. per annum upon the £60,000 sterling bonds of the company redeemable by the lessees in 1896. The election of directors for the ensuing year resulted in the appointment of the following gentlemen: Messrs. Thomas Swinyard, President; Hon. Frank Smith, Vice-President; H. S. Northrop, Alex. T. Fulton, General Thomas T. Eckert, Erastus Wiman, Charles A. Tinker, A. G. Ramsay and Henry Pellatt.

The Livonia Electrical Letters, Signs and Devices (Cox, Robinson and Gritton's Patents.)—These letters, &c., which have been designed to meet the need of a good day and night sign, consist of a galvanised iron outer case forming the letter or design to be shown. This case is lined out with reflecting surfaces fixed in the shape of a trough or V. In this trough, and following the contour of such letter, sign, or device, are arranged incandescent lamps of any desired candle-power, placed either in series or parallel, grouped on one, two or more circuits, according to effect desired, and placed at such an angle that a multiplied image of every lamp is obtained. When the lamps are illuminated the letters glow brilliantly under all conditions of weather. The main feature of the system as an advertisement consists, however, in placing lamps of different colours on separate circuits and alternately cutting the different lines connected to them in and out of the main circuit. The alternations of the different circuits are effected by means of a combined gravity, clock-work and electric motor switch of great simplicity. The spark on breaking the main circuit is very effectively dealt with no matter what the strength of current is. We may mention that the contacts are entirely made and broken under water. The cost of running this system may be estimated by taking 30-watt lamps as being most suitable for letters between three and five feet in height, and that 10 of these burning at one time will be quite sufficient to light them well. The cost of renewals has been found to be no more than the usual cost in any ordinary installation, the flashing not having any prejudicial effect on the lamps, and again owing to the fact of coloured lamps being used it is scarcely necessary to run them bright like the white lamps. We understand that several of these signs have now been working throughout this country for some months without a single fault, one of them being at the Trocadero Music Hall, London, and so far as our own observation goes, they appear to be admirably adapted for the purpose.

Long-Distance Telephony.—The Thornberry long-distance transmitter, an instrument much used in the United States and Canada, has now been introduced into this country by Messrs. Walter T. Glover & Co, and has proved itself of great service in connecting their offices in London and Manchester without necessitating a special line to the exchanges at either end, and the service is so good that Mr. Edmunds can by this means put himself in direct communication with the Manchester office, which is very important during his partner's prolonged absence from business. It is interesting to note that this simple long-distance transmitter can be used just as easily as the Blake, with which we are all so familiar.

Accident at a Private Station.—An accident occurred at the installation belonging to the Electric Construction Corporation, Walbrook, last Thursday. During the running two of the men were rendered unconscious by inhalations of coal gas in a heated atmosphere. It was not, however, serious, as the men resumed work with little delay.

Cable Testing.—The paper which we publish on another page by Mr. Carl Hering may possibly be found of some value to youthful electrical engineers, but we cannot help feeling that in matters of this kind America is years behind the times. American electricians seem to become suddenly famous amongst their own countrymen mainly through resuscitating the nearly forgotten ideas of electricians of a past age, and technical journalists in the States help on this rapidly gained notoriety through ignorance of the labours of earlier workers. Nearly 20 years ago the late Robert Sabine designed, and the British Telegraph Manufactory constructed, testing sets, in which all the measurements so lengthily treated by Mr. Hering were made simply by shifting plugs and without altering a single connection, and we should be much surprised if Messrs. Clark and Muirhead, or Elliott Bros., had not done the same thing. We would like to ask why Mr. Hering insists upon the positive pole of the battery being always to earth? Is it never necessary to take readings with both copper and zinc to line in America? Here it is always done in cable testing.

Elmore Again.—"An Original Shareholder," writing to the *Financial News* under date of the 20th inst., remarks that no doubt the readers of that paper as well as himself wondered at the fall in Elmore French and wire shares which took place the day previously. The writer, who has occasionally figured in our own pages, then goes on to explain, possibly to his own satisfaction, the reason of the drop, and exhorts his fellow shareholders not to be misled by the present market values. Every day that passes, he pathetically cries, proves more clearly and conclusively the value of the Elmore process; he is right, for people must by this time be regaining that little sense of which they have been temporarily bereft. M. Sécretan, he adds, is working heart and soul in the business; but even M. Secrétan's "heart and soul" cannot impart new life to a body possessing so little vitality of its own.

The Telephone in Spain.—Dalziel's agency, dating from Madrid, March 24th, states: The Spanish Government has published the conditions under which tenders will be received for the construction and working during a certain number of years of a complete network of telephonic lines, to be established between the principal towns in Spain. For this purpose the country will be divided into four districts. Telephonic communication must be established between the principal towns designated in each district, within 10 months after the date of the concession; with other towns of less importance, within a year from the same date; and with other places, within three years. All the apparatus employed must be of the most perfect description. The maximum charges to the public are fixed by Government, and the holders of the concessions will pay an annual sum to the State for each kilomètre of line. The full conditions under which tenders will be received are published in the *Madrid Gazette*.

Efficiency of Accumulators.—The central station in Dessau is the property of the German Continental Gas Company. The accumulators in operation last year are said to have yielded an efficiency of 78·9 per cent., although the rate of discharge was very irregular during the summer.

Mutual Telephone Company.—Messrs. Mix and Genest say that they supplied the Mutual with their "Spoon-shaped Receiver," which has proved a decided success.

A Notion from America.—We observe that Mr. John B. Verity has picked up a very good notion on one of his visits to our cousins over the water. One of the most effective modes of advertising in some of the American journals is that which takes the form of a periodical letter from the advertiser to his friends and customers, who cannot fail to become convinced by the freshness of such announcements as to new departures and developments that they must emanate from a "live" man, and one of the right sort for doing business with. It is the intention of Mr. Verity's firm to utilise one of our advertising columns in this way, and we feel sure it will be watched with interest by those engaged in the electrical industry.

Harwich Lighting.—Tenders are required for the public lighting of the urban district by electricity, gas, oil, or any other method, from 1st August, for the urban sanitary authority. Such tenders must be delivered at the office of Mr. A. J. H. Ward, town clerk, Harwich, by the 4th April, endorsed "Tender for public lighting."

Patent Ampères.—A correspondent has sent us a cutting from a paper circulating in the Lakes district which devotes a portion of its space to describing the electric launches which are to ply on Windermere. We notice that the *ampères and all electrical fittings* are Immisch's patents, and really, pending the final solution of the electrical units difficulty, we see no reason why everybody should not use his own particular patent ampère.

The Burning of the Japanese Parliament Houses.—The origin of the fire which destroyed the Japanese Houses of Parliament, at Tokio, two months ago, has been traced to the electric light wires in the building, which, states the *Elektricitäts Zeitung*, have been carelessly put up. The actual damage is estimated at £500,000. The Upper House has rented the Imperial Hotel, and the Lower House meets in the Hall of the Tokio Polytechnic School, until such time when the building can be re-constructed.

Electric Dentistry. — A demonstration of the new "Dental Vibrator" took place at the Institute of Medical Electricity, 35, Fitzroy Square, last Thursday, in the presence of several dentists, electricians, members of the Press, and others. The vibrator is an entirely new departure from the many contrivances hitherto devised for the same purpose. It does not depend for the resultant insensibility produced on the use of anæsthetics, but proceeds on the principle of setting up in the nerve of the tooth a series of extremely rapid vibrations, which effectually prevent the sensation of pain, the action of the instrument being divertant and not anæsthetic. The apparatus consists of a small Rhumkorff induction coil, made with an extremely fine wire, and having a delicate and highly-strung spring armature, which is strained by a clamp and screw at either end, and thus possesses great sensibility. The armature spring plays an important part in the operation of the instrument, its vibrations are at the rate of 452 per second. The patient is placed in the ordinary dentist's chair, and his position adjusted, with the aid of its fittings, to that most easy and convenient. The patient takes the negative electrode in his left hand and the positive in his right, and the current is allowed to flow for a few moments until the patient signifies that it is as strong as he can bear, when it is immediately cut off at that strength by means of a "switch," which is worked by the operator's foot. The forceps are then connected by a conductor with the other portions of the positive electrode, and, everything being prepared for the extraction, the patient grasps the handles as tightly as possible. The actual extraction is then at once proceeded with, the current being turned on for the purpose. The moment the tooth is extracted the current is cut off. The patient experiences no pain during the operation, but is merely conscious of a tingling of the hands and the forearms, resembling that commonly described as "pins and needles."

Electric Light Exhibition.—The directors of the Crystal Palace have decided to organise a second Electric Light Exhibition, which will be opened in the autumn.

NEW COMPANIES REGISTERED.

The London Rubber & Packing Company, Limited—Capital, £3,000 in £5 shares. Objects: To adopt an agreement dated the 4th inst. between G. Dixon of the one part and R. H. Wesencraft for the company of the other part, for the acquisition of the business carried on by G. Dixon, under the name of "The London Rubber and Packing Company," dealing in India-rubber, gutta-percha, leather and electrical goods, &c., at 47, High Bridge, Newcastle-upon-Tyne, and to manufacture, construct and deal in all kinds of electrical articles, appliances, and fittings, and leather, India-rubber and gutta-percha goods of every description. Signatories (who, with the exception of W. D. Hick with 5, take 10 shares each): G. Dixon, 47, High Bridge, Newcastle; R. Herron, 72, Northumberland Street, Newcastle; S. Percy, 161, Northumberland Street, Newcastle; A. Scott, Heaton, Newcastle; J. Tabb, Beechwood, Newcastle; W. D. Hick, 95, Pilgrim Street, Newcastle; R. H. Wesencraft, Quay Side, Newcastle. The number of directors is not to be less than three nor more than five. Qualification, 10 shares. G. Dixon is managing director. Registered on the 17th inst. by Jordan and Sons, 120, Chancery Lane, W.C. Registered office, 47, High Bridge, Newcastle-upon-Tyne.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Windsor and Eton Electric Light Company, Limited.—The annual return of this company, made up to the 13th inst., was filed on the 17th inst. The nominal capital is £30,000, divided into 5,950 ordinary shares of £5 each, and 250 founders' shares of £1 each. 250 £5 shares are taken up, upon 7 of which the full amount has been called and upon the remainder £4 per share has been called. The calls paid amount to £968 and unpaid to £39. Office, 54, High Street, Windsor.

The Taunton Electric Lighting Company, Limited.—The annual return of this company, made up to the 11th inst., was filed on the 16th inst. The nominal capital is £20,000 in £5 shares. 2,556 shares are taken up, upon 1,769 of which the full amount has been called. The calls paid amount to £8,845, and considered as paid, to £3,935. Offices, St. James's Street, Taunton.

Woodhouse & Rawson Electric Supply Company, of Great Britain, Limited.—The annual return of this company, made up to the 27th ult., was filed on the 19th inst. The nominal capital is £100,000, in £10 shares. 2,007 shares are taken up, upon all of which the full amount has been called. The calls paid amount to £20,070. Office: 11, Queen Victoria Street, E.C.

Northern Electric Wire and Cable Manufacturing Company, Limited.—The annual return of this company, made up to the 6th inst., was filed on the 18th inst. The nominal capital is £20,000, divided into 660 fully paid up and 3,340 ordinary shares of £5 each. All the fully paid up shares and 1,052 ordinary shares are taken up, and upon each of the latter £1 10s. per share has been called. The calls paid amount to £1,561 10s., considered as paid to £3,300, and unpaid to £16 10s. Office: Square Road, Halifax, Yorkshire.

Lineff Traction and Lighting Syndicate, Limited.—The annual return of this company, made up to the 14th of January last, was filed on the 19th inst. The nominal capital is £10,000 in £10 shares. 8,824 shares are taken up, upon 821 of which the full amonnt has been paid. The calls paid amount to £821, and considered as paid to £8,003. Offices: 11, Queen Victoria Street, E.C.

The Electro-Metallurgical Company, Limited.—The statutory return of this company, made up to the 26th January was filed on the 18th inst. The nominal capital is £2,500, in £5 shares. 182 shares are taken up, upon 2 of which the full amount has been called. The calls paid amount to *nil*, considered as paid to £900, and unpaid to £10. Office: 26, Waterloo Street, Birmingham.

Lane-Fox Electrical Company, Limited.—The annual return of this company, made up the 10th inst., was filed on the 20th inst. The nominal capital is £100, in £1 shares. 100 shares are taken up, upon none of which has anything been called. Offices: 2, Princes' Mansions, Victoria St., S.W.

Notting Hill Electric Lighting Company, Limited.—The annual return of this company, made up to the 11th inst., was filed on the 19th inst. The nominal capital is £100,000, divided into 550 founders' shares, and 9,450 ordinary shares of £10 each. 550 founders' and 6,452 ordinary shares are taken up. Upon 7 founders' and 134 ordinary shares the full amount has been called, and upon 543 founders' and 6,318 ordinary shares £6 per share has been called. The calls paid amount to £42,576. Offices: 9, Austin Friars, E.C.

CITY NOTES.

The Brighton and Hove Electric Light Company, Limited.

THE directors have pleasure in submitting to the shareholders the report of the operations of the company from the 1st January to the 31st December, 1890.

The profit and loss account, after writing off an ample sum for depreciation of plant (which has, however, been kept in thorough repair out of revenue), shows a balance of profit for the year of £768 2s., from which has to be deducted interest on debentures £123 6s. 7d., leaving a net amount of £644 15s. 5d., which, with the balance brought forward from last year's accounts, makes the sum to the credit of profit and loss account £1,202 15s. 1d.

The directors recommend that this shall be dealt with as follows:—

	£	s.	d.
Written off from "Suspense account, Garman case" (one-third of £697 6s. 10d.)	232	9	0
Dividend 5 per cent	750	0	0
Carried forward	220	6	1
	£1,202	15	1

The directors greatly regret that in consequence of the continued opposition of the Corporation of Brighton, they were last year again disappointed in their efforts to obtain a provisional order under the Electric Lighting Acts, 1882-1888. They have, however, this session applied to the Board of Trade for power to lay underground mains in that portion of Brighton which is not embraced in the area which the Corporation at present proposes to supply. In the event of this provisional order being granted, they are willing to withdraw their overhead wires from the Corporation area.

Should the application for the provisional order not be successful, the company will continue to supply throughout the whole of Brighton, including the area served by the Corporation, by means of its overhead wires; and it hopes to be able, by means of its greater economy of working, to make satisfactory headway against the competition of the Corporation.

During the past year every effort has been made by the company to come to terms with the Corporation, and the directors cannot help feeling that eventually the Corporation will acknowledge the desirability of making some arrangements with the company. By means of the company's system, every householder in Brighton can, at a fortnight's notice, obtain the electric light; whereas the low tension system laid down by the Corporation is not suitable for serving an extended district, so that the company's plant would most satisfactorily supplement the plant of the Corporation, if the two concerns were working in harmony.

The company has during the past year proceeded with the alterations referred to in former reports, and at the present time the whole of the company's supply is on the most modern system known, *i.e.*, the alternating current high pressure converter system, by means of which the excessive waste connected with the use of accumulators is avoided, as well as the heavy cost in mains, necessitated by the low tension system.

Failing coming to an arrangement with the Corporation, it is the intention of the directors to lay down additional plant in order to cope with the pressing demand from consumers outside the Corporation's proposed area of supply, and the attention of those shareholders who wish to subscribe a portion of the additional capital is drawn to the advantages offered by the company's debenture stock.

This consists of £15,000 debenture stock, which was created on the following terms:—

"These debentures, carrying 6 per cent. per annum interest, payable half-yearly, will be paid off at par at the end of five years from the date of issue. The company, however, reserve the right to redeem the entire issue at £105 per cent. at any time within the currency of the bonds, on giving three months' notice."

"On the other hand, any debenture holder will have the right to exchange his holding, or any part thereof, for a similar amount of ordinary shares at any time, even after he has received the notice of intended redemption, by giving one month's notice to the secretary of the company."

The Hove commissioners, who now hold a provisional order, have decided not to do the work themselves, but to let it out to a company; and in view of the fact that this company is already meeting all the present demands for electric lighting in Hove, the directors hope to get the preference with the Hove commissioners for any extensions of electric lighting which the commissioners may require.

The directors take the opportunity of thanking their customers for the loyal and hearty support which they have afforded to the company in the trying position in which the company finds itself placed.

During the past year Mr. Albert Gay has resigned his position as manager, having been offered the important post of manager of the House-to-House Electric Company's Works, West Brompton. Mr. Gay gave the directors great satisfaction, and they are sorry to part with him. Mr. Alfred Hodgson, who has been for the past four years secretary of the company, has been appointed manager in his stead.

Dnring the past year Mr. Frank Wilden Bentley has ceased to be a director, and the shareholders are invited to nominate some one—a local gentleman by preference—in his place.

If the company obtains its provisional order, or comes to a fair working arrangement with the Brighton Corporation, it will be desirable and agreeable to your board to invite the corporation to appoint a director to represent its interests and those of the ratepayers generally.

The retiring director is Mr. Arthur Kimber, who offers himself for re-election.

The meeting will have to elect an auditor or auditors for the ensuing year.

BALANCE SHEET, 31st December, 1890.

LIABILITIES.

	£	s.	d.
To authorised capital— 20,000 shares of £5 each ... £100,000 0 0			
,, Capital issued— 3,000 shares, fully paid	15,000	0	0
,, Debenture issue— 25 shares of £100 each, fully paid	2,500	0	0
,, Sundry creditors	2,417	7	0
,, Balance of profit and loss account on December 31st, 1889, brought forward	557	19	8
Add the profit for 12 months ended 31st December, 1890, after providing for 5 per cent. depreciation on plant, premises, and circuit (£768 2s), less interest on debentures (£123 6s. 7d.) ...	644	15	5
	£21,120	2	1

ASSETS.

	£	s.	d.
By plant (£9,365 11s. 4d.), premises (£1,753 4s. 7d.), circuit (£4,040 9s. 5d.), together £15,159 5s. 4d., less depreciation for current year, 5 per cent. (£757 19s. 3d.)	14,401	6	1
,, Installation stores	1,240	5	10
,, Electricity stores	93	17	2
,, Stock of coal and coal in trucks at railway station	156	12	3
,, Provisional order (amount expended)	1,713	7	5
,, Office furniture	55	4	2
,, Sundry debtors	2,112	18	8
,, Suspense account (Garman case)	697	6	10
,, Cash at bankers and in hand	649	3	8
	£21,120	2	1

PROFIT AND LOSS ACCOUNT from 1st January, 1890, to 31st December, 1890.

		£	s.	d.
	DR.			
To	Repairs to plant, premises, and circuit	489	14	9
,,	Amount written off for depreciation of plant and circuit, 5 per cent.	757	19	3
,,	Rent, rates and taxes	237	11	5
,,	Salaries	510	4	6
,,	Office expenses	348	16	8
,,	Directors' fees	195	0	0
,,	Wayleaves	88	18	8
,,	Bad debts	7	14	0
,,	Interest and discount	0	5	1
,,	Balance carried down	768	2	0
		£3,404	6	4
	CR.			
By	Net revenue from supply of electricity	3,361	11	9
,,	Net revenue from wiring new premises	42	14	7
		£3,404	6	4
	DR.			
To	Interest on debentures	123	6	7
,,	Balance	644	15	5
		£768	2	0
	CR.			
By	Balance brought down	768	2	0

The annual meeting was held on Tuesday night, Mr. Robert Hammond in the chair.

The CHAIRMAN, in moving the adoption of the report and balance sheet, said he would like to draw attention to the fact that the year's trading showed a balance of profit of £768 2s., and, after deducting debenture interest and bringing forward the balance from the previous year, there was available for division an amount of £1,202 15s. 1d. From this it was proposed to pay a dividend of 5 per cent. on the ordinary share capital of the company, £15,000. The dividend would absord £750, and out of the balance it was intended to write off a third of the £697 6s. 10d. which figured to the debit of the "suspense account Garman case," and was the amount of indemnity the company had to pay in connection with the sad accident, which was attributed by some to the company's negligence. It was already well known to them that the company's application for a provisional order in the Session 1889—90 was not successful, but the company had renewed its application, limiting the area to that portion of Brighton which lay outside the proposed corporation area, and in the event of its obtaining this provisional order the company would withdraw its wires and its opposition in the corporation area. Should, however, the application for the provisional order not be successful, the company would continue to supply the whole of Brighton, and would trust to its system and the greater economy which was possible under it, to make satisfactory headway against the competition of the corporation. It was a very gratifying thing to point out to the shareholders that the system which the company adopted some two years ago, the alternating current high tension transformer system, was now almost universally acknowledged as the only possible system for supplying electricity over an extended area by the leading electricians not only in this country but throughout the world. All the new work in America was being carried out on this high tension system, and practically one might say that only very old-fashioned engineers, who had not kept pace with the times, found themselves advocating the low tension system, which had its day and finished its career in the minds of serious people some six or eight years ago. For instance, during the past few months the City of London decided to grant powers to two companies, and, in both cases, the system which was practically worked out by this company in Brighton had been adopted. Speaking of the Corporation, their purse was a much longer one than the company's, and if it came to a question as to who could lose the most money, he quite acknowledged that the ratepayers of Brighton would be able to beat them on that score—(laughter)—but in an actual and fair working competition they (the company) would gain the victory. The company were doing their very best to come to an amicable arrangement with the corporation, and he personally had felt confident for some time past that it was greatly to the corporation's interest to come to an arrangement with the company. It would be noticed that the amount of capital at present invested in the company was £17,500, of which £2,500 was held in debentures. It was proposed to increase the debenture capital by a further £3,000, bringing up the total to £20,500. He would like to take this opportunity of correcting a misapprehension which existed in the minds of many ratepayers of Brighton, and which had been referred to in various observations that had been made in the corporation with regard to the company. There was an impression that the £17,500 share capital of the company was largely made up of promotion money, and did not actually represent plant. He could only say in reply that the original founders of the company bought a limited amount of plant compared with that which the company at present held for the sum of £2,000, and that after a further £2,000 had been spent upon it, it was valued at £8,000, so that the profit made in the formation of the company by those who were bold enough to purchase the old concern under the hammer, was £4,000 in shares. But the plant that was taken over by the company was valued at fully the £8,000 paid for it. Since then various important additions had been made, bringing up the present total to £17,500, and he had great pleasure in assuring the shareholders that during the past year the plant had been kept in repair out of revenue, and that for every penny that appeared on the balance-sheet the company could show a satisfactory asset. He had much pleasure in moving that the accounts and report be accepted, and that a dividend of 5 per cent. be paid.

Mr. CASH seconded the motion, congratulating the shareholders on the position of the company under adverse circumstances, and complimenting the directors on their management of its affairs.

The motion was carried.

On the motion of the CHAIRMAN, seconded by Mr. CASH, Mr. Kimber was re-elected a director. Messrs. Ball, Baker, Rowe & Co. were reappointed auditors, on the motion of the CHAIRMAN, seconded by Mr. KIMBER.

The Telephone Company of Egypt, Limited.

THE report of the directors for the year ending 31st December, 1890, presented at the eighth ordinary general meeting of the company, on Tuesday, stated the revenue account, after providing £345 for interest on debentures shows an amount to credit of £3,670 10s. 1d., adding to this the sum of £1,459 1s. 4d. brought forward from 31st December, 1889, there remains a balance for disposal of £5,129 11s. 5d., out of which the directors recommend the payment of a dividend of 6 per cent. on the preferred shares, free of income tax, carrying forward £1,508 5s. 5d. Considerable expense has been incurred during the past year in the renewal of lines and instruments, all charges in connection therewith having been provided for out of revenue. The directors have also deemed it advisable to eliminate from the accounts certain subscriptions, the collection of which appear doubtful. A further issue of £1,500 6 per cent. debentures was made during the year, in order to replace a portion of the revenue that has been expended on capital account. The business at Alexandria and Cairo shows a less favourable tendency, due to local circumstances. The growth of the exchange at Port Said, on the other hand, has more than fulfilled the expectations of the directors, and this exchange will in time add to the income of the company. A small exchange was opened during the year at Assiout, and negotiations are now in progress for the establishment of an exchange at Suez, with a branch at Port Tewfick. The gross revenue of the company at 31st December, 1890, was £10,852 8s. 2d., and the total number of subscribers in Egypt, 994. Under the articles of association Mr. Henry Grëwing retires from the direction, but being eligible offers himself for re-election. Messrs. Price, Waterhouse. and Co., the auditors of the company, also retire, and offer themselves for re-election.

The SECRETARY having read the notice convening the meeting,

The CHAIRMAN said: Gentlemen, I assume that the report and accounts, which have already been placed before you, may be taken as read. I think that during the past year the business has been kept up to a fair point of prosperity, though, in fact, so far as accounts are concerned, the profits are £340 less than in 1889, but the benefits arising from the establishment of exchanges at Port Said and Assiout will only be felt in this and the following years, while the working expenses have been necessarily increased on their account. I think you must wait upon the reviving prosperity of the country for any large extension of the business. The wires are for the most part being renewed with phosphor-bronze, and the replacing of some very large poles has also added to the expenses. These charges have also been met out of revenue, and as the manager reports that all the lines are kept in working order, the directors have not thought it necessary to reduce the capital value of the company. Charges against revenue may become larger in future years on account of maintenance, but so long as the lines and instruments are kept in good order from revenue there is no reason to make any charge for depreciation. You are no doubt aware that much trade has been transferred from Alexandria to Port Said and Suez, and as a consequence our business at Alexandria has fallen off to some extent; but Alexandria will always remain a place of considerable importance, and any falling off there will be certainly compensated by the establishment of telephonic communication at Port Said and Suez. We have already opened at Port Said—I think we said so in our last report—and though we have not yet opened at Suez, we are under negotiations for that purpose, and hope it will be established this year. We have had negotiations from time to time with the Egyptian Government as to the establishment of telephonic communication between Cairo and Alexandria, but the directors have not been able to come to a conclusion that such a line—which will cost no less than £12,000 to be efficient—would bring even a moderate return to the company. Perhaps, as the financial condition of the country improves, it may be worth while for the Government to establish a line, allowing the company to work it in connection with their exchanges at its ends, or to make some arrangement whereby the expenditure should not be entirely at the company's risk. The matter will continue to have the directors attention. The directors believe the service is carried on with the greatest efficiency; at all events, we have had no complaints from subscribers, and as this is due to the careful supervision of Mr. Evans and his staff in Egypt, the shareholders will, I hope, be able to express their satisfaction with the services of the Egyptian staff. Our staff expenditure has also been kept at a moderate scale by our able secretary, nor are the directors dilatory in requiring the explanation necessary to enable them to authorise it. While our expenditure is at the lowest point consistent with efficiency, and the dividend remains at only 6 per cent., subscribers in Egypt cannot expect our moderate charges for services rendered to be reduced, though we hope this may be possible when the trade of the country improves. The committee in charge lend their aid to the superintendent in matters of importance when they arise, and advice is desired by the board, and our thanks are due to these gentlemen for thus gratuitously giving their time.

No questions were asked or opposition offered, and the Chairman having moved the resolution approving the report and accounts, and declaring a dividend of 6 per cent., it was seconded by Mr. Henry Grëwing, and unanimously carried.

The last mentioned gentleman, who was retiring by rotation from the board of directors, was re-elected, as also the auditors, Messrs. Price, Waterhouse & Co., and the usual vote of thanks concluded the meeting.

Elmore's Foreign and Colonial Company.—The directors of Elmore's Foreign and Colonial Patent Copper Depositing Company, Limited, have called meetings for April 6th to alter the articles of association to enable them to distribute amongst the shareholders the assets held by the company, and represented by shares and debentures of the French and Austrian companies. If these clauses are altered so as to enable the directors to distribute the above securities as though they were dividend in specie, they will immediately propose a distribution equivalent to £6 per priority share and £5 per founders' share, reckoning the securities to be divided at their par value.

The Telephone Company of Austria, Limited.—This company have declared the usual half-yearly dividend to the 30th inst., on the preference shares at the rate of 6 per cent. per annum, payable, less income-tax, early in April.

Elmore's Austro-Hungarian Company.—Thursday, April 2nd, has been appointed settling day for shares numbers 1 to 50,000.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The receipts for the week ending March 20th, 1891, amounted to £6,174.

The City and South London Railway Company. The traffic receipts for the week ended March 21st, amounted to £766.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending March 20th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £5,102.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (March 19).	Closing Quotatiion. (Mar. 25)	Business done during week ending March 25, 1891.	
					Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	47½— 48½	47 — 48	48	47⅜
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84½— 85½	84½— 85½	85½	84¾
2,809,310*l*	Do. do. Deferred	Stock	11 — 11½	11 — 11½	11¼	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼xd	12⅛	11⅞
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2¼— 2½	2⅜— 2⅝	2⅜	2¼
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2	1¾— 2	1$\frac{13}{16}$	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	5½— 6½	5½— 6½	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	108 —110	107 —109 xd	108½	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	$\frac{7}{16}$— $\frac{9}{16}$	$\frac{7}{16}$— $\frac{9}{16}$	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16½— 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¾— 4¼	3¾— 4¼xd	4⅛	...
6,000	Do. do. 10 p. c. Preference	5	9½— 10½	9 — 10	10	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10¼	10⅛
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜	14⅛— 14⅜	14¼	14⅛
70,000	Do. 6 p. c. Preference	10	15¼— 15¾	15¼— 15¾	15¼	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	107 —110	107 —110	108¾	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14¾— 15	14¾— 15	15	14$\frac{13}{16}$
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	104	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	103½	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	104 —107	104 —107	105¼	...
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	106	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5 — 6	5½— 6½	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1 — 1½	1 — 1½	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3 — 3½	3 — 3½	3	...
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1 — 1½	1 — 1½	1⅜	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9¼— 9½	9⅛— 9⅜	9$\frac{5}{16}$	9$\frac{3}{16}$
180,042	Do. do. 6 p. c. Preference	10	15 — 15¼	15 — 15¼	15$\frac{1}{16}$	15
150,000	Great Northern Tel. Company of Copenhagen	10	17 — 17½	17 — 17½	...	...
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	103 —106	103 —106	106	105½
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	11¼	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	19 — 20	19 — 20	19½	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	102 —104 xd	...	...
17,000	Indo-European Telegraph, Limited	25	38 — 40	39 — 41	40	39⅜
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7 — 8	7 — 8	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105—108	105 —108	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	8¾— 9¼	8¾— 9¼	8⅞	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 4⅝	4⅜— 4⅝	4⅝	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	12¾— 13¼	12¾— 13¼	13$\frac{3}{16}$	...
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	$\frac{5}{16}$— $\frac{7}{16}$	$\frac{5}{16}$— $\frac{7}{16}$	...	...
9,000	Reuter's Limited	8	8½— 9	8¾— 9¼	...	...
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ¼	⅛— ¼	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	...	...
37,350	Telegraph Construction and Maintenance, Limited	12	45 — 47 xd	45 — 47	46	...
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	97 —100	97 —100	...	...
30,000	West Coast of America Telegraph, Limited	10	2 — 3	2 — 3	2$\frac{9}{16}$	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	92 — 97	92 — 97	...	...
64,174	Western and Brazilian Telegraph, Limited	15	12 — 12½	12 — 12½	12⅜	12⅛
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6¾— 7¼	6¾— 7¼	6¾	...
27,873	Do. do. do. 5 p. c. Deferred	7½	5¼— 5¾	5¼— 5¾	5$\frac{9}{16}$	...
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 —106	103 —106	106	105
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	2¾— 3	3	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11½— 12	11½— 12	11$\frac{13}{16}$	11⅝
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11½— 12½	11½— 12½	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100—104	100 —104	...	..
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3¾— 4	3⅞— 4⅛	...	...

* Subject to Founders' Shares.

Latest Procurable Quotations of Securities not Officially Quoted.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅝.—City of London Electric Lighting (Pioneer), Shares of £50, £25 paid, 55—60.—Elmore's Austrian Copper Depositing, 20s., 10s. Dis.—Elmore's Priorities, 3¾—4.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 2¼—2½.—Manchester Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—St. James's and Pall Mall Electric Light £5, 6¼—6½.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2—2½.—Preference, fully paid 3⅞—4½.—Debentures 90—95.—Woods Electric Car, £10 paid, ¾—1¼.

Bank Rate of Discount.—3 per cent. (29th January, 1891).

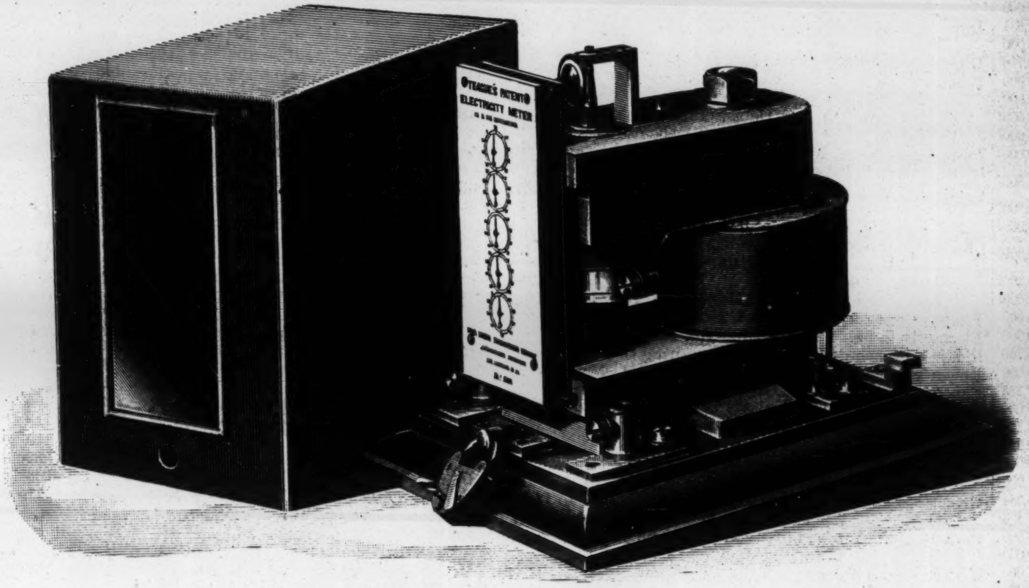
THE ST. PANCRAS ELECTRICAL EXHIBITION.

Second Notice.

The Acme Electric Works.

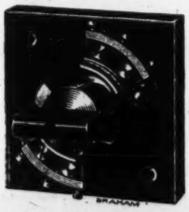
Amongst the more important articles exhibited at the stand of the Acme Electric works may be mentioned the following:—

Teague's Patent Electricity Meter, direct reading in B.T. units, no constants or multiplier being required. It is a simple form of electromotor, the armature of which consists of a hollow non-magnetic cylinder through which the current passes, contact being made by the lower edge, and end, of armature and spindle, dipping into troughs of mercury, in which by a special arrangement the mercury is prevented from spilling and the action of the atmosphere reduced to a minimum. The armature is enclosed in a strong magnetic field, and the speed is directly proportional to the current passing through the armature. The range of the smallest size meter is from ·5 to 10 ampères, which is twenty-fold, and in the larger sizes it starts with a proportionately smaller current.



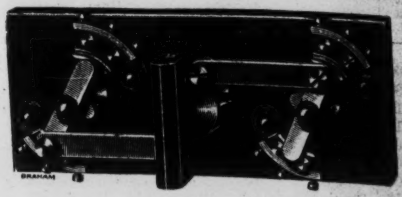
Teague's Electricity Meter.

Improved Patent Cockburn Quick Break-lock Switches.—These switches are now constructed on an entirely new principle, the amount of spring necessary to ensure the ends of contact brush bedding firmly on the terminal plates being obtained by the flexibility of the brush itself, which is constructed of extremely thin rolled copper. The terminal plates are segments of a circle, being made adjustable, and by means of screws can be so arranged as to compensate for considerable wear on the brush. They are mounted on enamelled slate, and the ends of brush turned to a corresponding curve as shown in illustration. These switches are also made coupled as in the former types and are arranged to carry from 15 to 1,000 ampères and upwards.



Small S.P. Switch (New Pattern).

Large S.P. Switch (New Pattern).



Coupled D.P. Switch (New Pattern).

They are also mounted on enamelled slates for main and branch switchboards in combination with safety cut-out.

New Combined Improved Ayrton & Perry Magnifying Spring Volt and Ampère Meters are now made in several sizes. There are two scales on one dial with only one pointer for both, and one terminal common to both circuits three only being required. Special precautions are taken to ensure good insulation, and the indications are all guaranteed correct to within 1 per cent.

Spring Ammeter.

Ayrton & Perry's New Patent Twisted Strip Ampère and Volt Meters, designed to replace the old hot wire instrument. It is adapted for use with small E.M.F.'s and currents, and is calibrated to read in

Ayrton & Perry Combined Volt and Ammeter.

100ths of volts and ampères, and its indications are correct to within ·5 per cent. They are arranged for use either vertically or horizontally.

KEYS' ELECTRIC COMPANY.

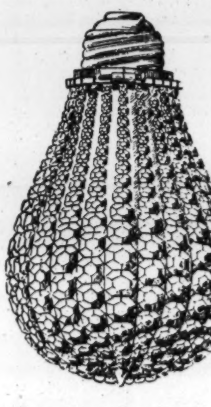
One of the prettiest exhibits is that of the Keys' Electric Company, Limited; over the entrance to their room are the letters K. E. C., formed by incandescent lamps in green, red and white. The interior, which is most tastefully arranged, contains a number of domestic machines—mangle, washing machine, sewing machine, electric fan, &c, in constant operation. There is also an electric tea urn, which boils water in five minutes and an electric cigar lighter. Among the numerous other exhibits may be mentioned a well-finished switchboard with the new "revolver switches," which are much admired; as well as a large quantity of Dolivo ammeters and voltmeters, electroliers, and fittings of rare artistic merit. As a curious incident, we may state that during the opening ceremony, the only time when the electric light was at all visible, happened whilst the Lord Mayor inspected the Keys Company's room for the space of about a quarter of an hour, and his lordship in his opening speech referred especially to the numerous useful appliances which he happened to notice during this favourable interval.

THE GENERAL ELECTRIC POWER AND TRACTION COMPANY

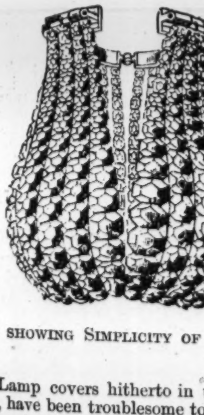
Have an extremely interesting show of electric motors, switches, electric light fittings and accessories. Small electric motors are in operation, driving some of Messrs. Bradford's well-known domestic machinery—wringing machines, washing machines, &c., as well as one of "Ovens's" sausage making machines. This company have in constant operation at their stand a very neat contrivance for ventilating; the electric motor and fan are mounted on the same spindle and make a handy method for keeping a constant supply of fresh air in circulation in saloons, theatres, churches, halls, and similar places. Electric drills for drilling holes of $\frac{7}{8}$ths inch to 1 inch in metal are also shown. Artistic electric light fittings of all descriptions are exhibited, and several unique types of drawing-room and library lamps give the visitors an idea of the extent of the company's manufactures.

RASHLEIGH PHIPPS AND DAWSON.

We give this week an illustration of the much admired "bead ray diffuser," referred to in our last as being an attractive feature at the stand of Messrs. Rashleigh Phipps and Dawson. It will be seen that the construction is very simple and that the framework on which the beads are arranged can be fitted to any existing lamp by simply turning a screw. Lamp covers hitherto in use, such, for instance, as those made of silk, have been troublesome to keep in good order and have required frequent renewal, but these diffusers will be much more economical owing to the long time they will wear. The purpose they serve is to break up the colourless light into brilliant and subdued rays, at the same time affording additional security in case of a broken lamp. The samples shown at present are each either of white beads or of beads of some single colour, but it is intended, by various combinations and arrangements, to produce diffusers of such distinct tones and tints as to meet every requirement as to colour.



ELECTRIC LAMP WITH RAY DIFFUSER ATTACHED.



SKETCH SHOWING SIMPLICITY OF ATTACHMENT.

LONDON CHAMBER OF COMMERCE ELECTRICAL TRADES SECTION.

THE Electrical Trades Section of the London Chamber of Commerce met on Friday last at Botolph House. In the absence of Mr. Crompton through illness, Mr. Garcke acted as chairman. The secretary read the minutes of the previous meeting which were confirmed.

THE TELEPHONE CLAUSES IN ELECTRIC LIGHTING ACTS.

The secretary read the report of the committee appointed on the 26th January to consider the telephone clauses in the Electric Lighting Acts.

The report stated that when, in the Session of 1889, the first large batch of provisional orders were applied for consequent upon the passing of the Amendment Act of 1888, the question of the protection to be given by the orders to the telephone companies was naturally raised, and in order to settle the matter a meeting was held at the Board of Trade, at which meeting the clause inserted by the Board of Trade in all electric lighting orders of 1889 was settled after discussion. This clause was the result of a compromise, but was considered by the parties present, including the Board of Trade, to be the best that could be adopted in the conflicting interests of the parties, *it was not, however, deemed wholly* satisfactory by either the telephone companies or by the electric lighting companies, but it was inserted in all the 1889 provisional orders, all but three of which related to the Metropolis. This clause of 1889 was subsequently adopted by the Board of Trade in the model order issued by them in 1890.

During the Session of 1890, a very large number of provisional orders were granted by the Bcard of Trade. In the great majority of these the the 1889 clause was inserted by the Board of Trade, and no objection was taken to that clause by any of the parties promoting the orders, or by the telephone company.

Certain of the local authorities, however, tried to amend the clause in their own favour, and the Board of Trade (which authority, it may be stated, has made it part of its policy to pay the greatest deference to the wishes of the local authority), without expressing any opinion on the merits of the difference, decided not to take the responsibility of determining the difference, but to refer the matter to Parliament. The machinery by which this was done was by altering the clause and leaving the telephone company to petition, but the Board of Trade distinctly disclaimed having settled the clause in the altered form, and explained this to the chairman of the committee.

The question thus raised came up first before the Committee on the Electric Lighting Provisional Orders Confirmation (No. 6) (Birkenhead Electric Lightiug Order) Bill, on the 3rd July, 1890.

The night before that Bill came into committee, the Board of Trade wrote to the various agents representing the promoters of provisional orders, stating that the question was coming before the committee on the Birkenhead order (without saying when), and that the clause settled by the committee would be inserted by them in all provisional orders of the Session.

Your committee understand that this notice was received by some agents so late that they could not get to the committee room in time even to be present at the discussion, or until after the question had been decided.

Moreover, it is clear that the question was merely one between the promoters of the Birkenhead order and the other promoters who had objected to the clause as agreed in 1889 (all of whom were represented by the same agents), and their opponents, and that neither the representatives of the London companies nor the promoters of other orders had any locus to be heard by the committee.

This committee, however, settled a clause which is *admittedly more favourable* to the telephone companies than the clause of 1889, and the Board of Trade, in pursuance of the determination, of which notice was so tardily given by them to the other promoters, took steps to insert this clause in all pending provisional orders.

Your committee desires that the section should clearly understand that when a Provincial Order Confirmation Bill comes to Parliament, the promoters of a provisional order have to promote it *in the form in which it has been granted by the Board of Trade*, that they have no power to ask the committee to alter the form of the order in any manner, and that no question can be raised by any one upon the order except with the consent of the Board of Trade, or upon petition presented by parties having a locus *against* the order.

Your committee are informed that it so happened that a great many orders affecting London and other places had been granted by the Board of Trade, with the telephone protection clause of 1889 inserted, and that the confirming Bill had been introduced into Parliament prior to the date when the committee considered the Birkenhead order.

Many of these Bills, however, were not opposed, and none of them by the Telephone Company (who had throughout expressed their readiness to abide by the settlement made in 1889), and came therefore before Mr. Leonard Courtney, the chairman of committees, as unopposed Bills.

The Board of Trade gave notice of their intention to request the chairman to insert the Birkenhead committee clause in lieu of the clause inserted in the order as granted.

When the question came before Mr. Leonard Courtney, he decided that in the face of opposition by the promoters of the order, he could not make an substantial alteration, even at the instance of the Board of Trade, and in those cases therefore where the order had been granted previous to the decision of the Birkenhead committee, and objection to the proposed alterations was made by the promoters, the 1889 clause remained.

The Board of Trade, however, inserted the 1890 clause into the orders subsequently granted by them, and (notwithstanding the opposition of the promoters, and the fact that the telephone companies did not ask to have the clause of 1890 inserted, but expressed their concurrence in the agreed clause of 1889 being adhered to), declined to make any alteration.

Your committee, however, are informed that in the case of the City of London provisional orders, the last two granted by the Board of Trade, during the Session of 1890, the Board of Trade, at the request of the Commissioners of Sewers for the City, agreed to the 1889 clause being inserted in the House of Lords in these orders in lieu of the clause of 1890, which they had inserted in the orders when granted.

For the convenience of the section, printed clauses of the Sessions of 1889 and 1890 are attached to this report.

Your committee understand that the Board of Trade's action in the matter was governed by the following considerations:—

They say that in 1889 the responsibility of dealing with the question *had been taken out of their hands* by the agreement come to between the parties.

The Board of Trade therefore determined to insert such agreed clause in all orders.

They departed from this, however, at the request of a local authority, with the result that a committee of the House settled the clause. The Board of Trade thereupon came to the conclusion that their proper course was to put the committee's clause into all pending orders, without reference to locality, or to the expressed wishes of the telephone and electric light companies.

At the request of a local authority the Board returned to the 1889 clause in the case of the City of London Orders.

The Board of Trade have, however, not acted consistently to the course of procedure thus laid down by them.

During the present session some 70 to 80 provisional orders are being promoted, and the Board of Trade, in the model order which they have issued, have put forward a third clause on this subject differing from the clauses of 1889 and 1890, and again altering the rights of the two sets of parties.

Your committee feel strongly that while the Board of Trade are the protectors of the rights of the public in dealing with these matters, and are perfectly justified in altering the conditions which they think necessary to impose upon undertakers in the interests of the public, or of the safety of buildings or otherwise, or as to the prices to be charged and so on, should not lightly take away from two sets of people the right to contract as to the relative positions of such parties in carrying out their undertakings.

It is true that the electric light companies only carry on their operations under statutory authority, and that the telephone companies have no statutory authority.

The telephone companies were, however, so to speak, in the field, and carrying on a lawful business when the electric lighting companies were promoting their orders.

The Telephone Company therefore had a right to say: You shall not injuriously affect our business, but we will be satisfied if you will give us certain clauses for our protection, and the electric light undertakers had also the undoubted right to say we will give you such protection, but no more.

Your committee moreover admit that in cases where there is a contest as to the proper clauses to be inserted, the Board of Trade was no doubt justified in abiding by the precedent set them by a committee of the House under similar circumstances. But your committee cannot understand why the Board of Trade should think it necessary to intervene between the only parties interested, and say that those parties shall not be entitled to settle by agreement the quantum of protection to be given by one to the other.

It has been suggested that the Board of Trade in this matter are protecting the rights of the Postmaster-General, as the telephone companies carry on their business under a license from the Postmaster-General.

The rights of the Postmaster-General are, however, expressly reserved by the orders granted, and anything that is arranged between the undertakers and the telephone companies can in no way affect these rights.

It would, therefore, seem to your committee that the Board of Trade in dealing with this question are unnecessarily curtailing the rights of electric lighting and telephone companies to agree amongst themselves how far one is to take precautions against interference with the property of the other. For, as already stated, the essence of the clauses is protection to the telephone companies.

In the Birkenhead case, moreover, the two parties did not agree, and the committee was asked by the parties to settle their dispute.

Your committee feel that it is most desirable that steps should be taken by the Chamber of Commerce on the question of principle, as they feel it is most desirable in the interest of those who have invested and are investing capital in these undertakings, that they should not be put to the continual expense of discussion every session, both with the Board of Trade and Parliament, how far one of them is or is not to be protected, that there should in fact be some finality to the discussion, and that the rights of the parties to contract with each other should not be disturbed.

Your committee feel that it is not for them to suggest what steps the section of the Chamber of Commerce should take upon this report, but they do feel very strongly that the representations should be made to the Board of Trade, based upon the principles to which they have here referred.

The report was signed by Colonel Jackson and Mr. Winterbotham on behalf of the telephone companies, and by Mr. E. Garcke and Sydney Morse on behalf of the electric light companies.

Some discussion followed the reading of the report.

Mr. Sidney Morse read a letter from the Board of Trade, saying that the telephone companies had informed them that they intended to oppose all provisional orders for their protection unless satisfactory to them, and that the railway companies did not consider the clause, as it stood at present, afforded adequate protection to their telegraph lines. Speaking on the subject he said that he had written to the Board of Trade, pointing out that the 1889 clause had been agreed on by the telephone and electric light companies, and pressing them to insert it in their orders in place of the clause of 1891. The Board of Trade had replied that they had considered the matter, but could not do as requested. Members of the chamber were probably aware that the custom in private legislation was for the opponents of a bill to approach its promoters and offer to withdraw their opposition, provided the clause they desired should be inserted. The clause was usually inserted as a matter of course, and the opposition withdrawn. He had supposed the Board of Trade would follow the same course with provisional orders, but they had refused to do so. Promoters of an electric lighting provisional order were in a great difficulty when coming to the House of Commons for confirmation, They could not alter a word whilst anyone else might object. If he, as representing an electric lighting company went to the Board of Trade with a clause agreed on between himself and the telephone companies, no notice was taken, but when a telephone company threatened to oppose an order in Parliament unless it was made satisfactory to them, the Board of Trade gave way. The telephone companies had signed the report and were prepared to join the Chamber of Commerce in approaching the Board of Trade and pressing for the 1889 clause, but unfortunately they had already informed the Board of Trade that the model clause as altered, was satisfactory to them.

Colonel Jackson said the telephone companies were quite prepared to accept the 1889 clause as a general clause, and if they could prevail upon the Board of Trade to adopt it under all circumstances they would do so. He did not think Mr. Morse could ask more than that. He could hardly expect them to refuse every order but that. They were agreed that the Chamber of Commerce should be invited by the section to use its influence in the report they had made, but they could not fight against an order which suited all their purposes. Such a course might lose them both the model order and the new one.

The Chairman said the best course which could be pursued would be to ask the Chamber of Commerce to take some step with a view to making the report effective, and, if Colonel Jackson agreed, they might pass a resolution asking him and the telephone companies to support the report by joint action with the electric light companies before the Board of Trade.

Col. Jackson, speaking for himself, had no objection to such a resolution being passed, but, of course, he had colleagues. Accordingly, a resolution was moved by Mr. C. J. Wharton, and seconded by Colonel Jackson, calling on the Council of the Chamber to embody the substance of the report in a letter to the Board of Trade and to support it by a deputation attended by both interests.

This was carried unanimously.

Co-operation of Telephone and Electric Lighting Companies in the Laying of Underground Cables.

The Chairman said this was the next matter on the agenda. It was to have been brought forward by Mr. Crompton who, unhappily, was too ill to attend.

Colonel Jackson said there were some features in the suggestion that might be valuable, and so far as the telephone companies were concerned they were prepared to discuss the matter. The section can do no more than bring the interests together, because to give effect to Mr. Crompton's suggestion there would have to be negotiations between the electric light and telephone companies, as, for instance, on such questions what should be the relative shares borne in the cost of laying a main, what should be paid for mains already laid, also for application to the Board of Trade for power to allow the telephone companies to lay wires for the electric lighting companies and *vice versâ*.

The Chairman said it was obviously to the advantage of both that the streets should not be unnecessarily taken up, but as there was no motion before the meeting he thought the matter had better be postponed.

This was agreed to.

Overhead Wires.

The report of the sub-committee on overhead wires had been previously circulated and was taken as read.

The Chairman said they would all notice how unfairly they were treated. No other industry was hampered in the same way. The matter had been before them for some time; but they could only pass a resolution to make a strong representation to the Board of Trade on the subject.

Mr. C. J. Wharton suggested that it would be a good plan to allow the report to be published in the technical press. Perhaps they could thereby create a consensus of public opinion in their favour. Taking experience within his own knowledge of that year, through all the bad weather he had never had a wire break down which had been put up in defiance of the Board of Trade regulations, though several had which had been put up in accordance therewith.

PROCEEDINGS OF SOCIETIES.

Society of Arts.

ELECTRICITY IN RELATION TO THE HUMAN BODY, ITS DANGERS AND ITS USES.*

By H. NEWMAN LAWRENCE, M.I.E.E., and ARTHUR HARRIES, M.D., A.I.E.E.

The subject we have chosen for this paper is one of much interest at the present time. It is intimately connected with the practical utilisation of one of the most valuable developments of modern science, and it also concerns each of us individually.

The connection between electricity and the human body might at first sight seem rather remote, and any attempt to show a close relationship would, a few years ago, have been thought unnecessary and unprofitable.

Now, however, that electric light is in our houses, electric power in our workshops and in our streets, electric telegraphs and electric telephones in our offices, and a considerable section of the public is making more or less use daily of these appliances, it is but natural to turn attention to a consideration of the influence this powerful, yet mysterious, agent has upon the human body.

The full consideration of such a subject would be far more than could be possibly dealt with in this paper, though records of facts connected therewith are few and far between. Our subject possesses little or nothing in the nature of a history, so we hope we may be excused if we deal with the matter mainly in the light of our own experiments and observations.

It is manifest that any consideration of the relation between electricity and the human body must divide itself into two parts: the one, *possible dangers* to the body, and the other, *possible advantages*.

We deal with the dangers first:—

First among the dangers is that from lightning; but this is one which we need hardly enlarge upon here. That lightning is distinctly dangerous, and often fatally so, to the human body, is a well recognised fact, and one which is, for the most part, sufficiently guarded against. The physiological problems connected with lightning stroke are many and interesting, but beyond our present scope.

We have rather to deal with dangers arising from accidental contact with conductors which are used to convey electric currents to and from the various lamps, machines, or apparatus they are intended to actuate.

Danger from contact with telegraph, telephone, and electric bell conductors is infinitesimal; for the currents they carry ordinarily are so small, that the worst that could happen, on making contact, would be a slight shock to the nervous system. The smallness of the currents carried would prevent any real electrical danger. Still, it sometimes happens that such conductors receive, through accident to other wires, currents many times greater than they ordinarily carry. Under these circumstances, contact with them becomes distinctly dangerous. While, therefore, we cannot speak of serious consequences likely to result ordinarily from contact with telegraph, telephone, and bell wires, we think they are best left alone by others than those whose special duty it is to look after them.

Conductors of light and power circuits do, however, convey currents which possess great possibilities of danger to the human body, and, therefore, should be so placed and so insulated as to render it impossible for members of the general public to come in contact with them.

That electric engineers (in England at any rate) have done, and will do all that is possible to safeguard the public we gladly believe and acknowledge. With proper care on the part of the engineer, and with a minimum of caution on the part of the public, accidental contact by the human body with conductors carrying dangerous currents becomes almost an impossibility; but it does not by any means follow that information as to the consequences to the body of any such accidental contact should not be made known. To be forewarned is to be forearmed.

The results of contact with currents passing at a fixed rate of E.M.F. (as is generally the case in light and power circuits) depend upon resistance, sensation, and local effect. Upon the resistance offered by the body depends the quantity of current passed; sensation and local effect are produced upon the body by such current as it really receives.

Resistance, in its turn, depends upon the condition of the skin at the sites of contact, and upon the extent of the contact area. These points are all-important in deciding the seriousness, or otherwise, of accidental contact.

We have noted with regret that there is a tendency among electrical engineers to draw unfair inferences from the slight results which have sometimes followed accidental contact. They argue that, because A received no harm from an accident on a particular circuit, therefore no harm can come to B and C, or anyone else, on the same or some similar circuit, quite forgetting that A's hands may have been exceptionally dry, or that the area of his skin in contact may have been very small.

We have made experiments on both these questions, and find as follows:—

CONDITION OF SKIN TABLE.

Electrodes of 45 *Sq. C. held in each hand; Dynamo Currents at from* 100 *to* 115 *Volts.*

	To continuous current resistance.	To alternating current resistance.
Dry	6,185 ohms.	4,008 ohms.
Moist	2,450 „	1,622 „
Wet	1,510 „	1,360 „

From this it appears that, with continuous current, resistance with the skin moist at point of contact is about one-third the average of that found when the skin is dry. With wet skin, resistance is further reduced to one-fourth. With alternating current, the proportionate decrease of resistance between the conditions of dry, moist, and wet skin, is slightly less, but is still well marked.

These results were obtained, as before mentioned, with dynamo currents at about 100 volts; and it is interesting to note that nearly the same proportion appeared in the "Comparative Resistance Table," obtained with battery and coil currents, which we had the honour of putting before the Institution of Electrical Engineers in a paper in March, 1890; though the actual values there given were much higher with continuous currents.

Some surface area tests were briefly referred to in our paper read before the British Association in September last, on "Alternating *v.* Continuous Currents in Relation to the Human Body (Dynamo Currents)." We have now embodied therewith other observations taken since, and find that, other conditions being the same, the current passed with a given E.M.F. is as nearly as possible in direct proportion to the surface area in contact.

These results show at a glance how very large is the influence which these factors of skin condition and contact area have.

By them we find that, while it is possible for A to receive only about 4 milliampères from a circuit carrying a current of 100 volts if his skin be dry, and the contact area be 10 sq. c., it is equally possible for B to receive 800 milliampère from the same circuit, if his skin be moist and 500 sq. c. of it be in contact. In other words, the possibilities for harm are dependent upon these factors to such an extent, that when both are favourable to the subject, contact with wires carrying current in the highest degree dangerous, may produce results in no sense serious on the other hand, when both are unfavourable, the subject may receive serious if not fatal injury, from a circuit which might be safely handled under conditions more favourable to himself.

We now come to the consideration of what happens to the body, when the resistance has been sufficiently overcome to allow a perceptible current to pass through. The results may be classed under two heads, viz.: Sensation and Local Effect.

Sensation.—We have made many experiments to determine how the sensations of individuals are affected by currents of such strength as could be borne. The results of these have already been published in detail in the papers above referred to, so we will here only summarise them.

We find with dynamo generated currents, when bare metal electrodes, having a surface area of 45 sq. c. each, are grasped in the hands so that the current passes through the arms and chest, that with continuous current at 104 volts, an average current of 0·0183 ampère produced what we have called discomfort point, while with alternating current at about the same voltage (and a frequency of 23 per second) 0·007 ampère was sufficient to produce comparable discomfort.

Further, that with the alternating current 0·0079 ampère produced muscular fixation, while with the continuous current in no case was muscular fixation, or any sensation approaching thereto, reached.

Local Effect.—The action of currents upon the parts actually brought into contact with conductors has scarcely received sufficient attention, nor have we been able to find any detailed description of the effects observed.

It is proposed in the present paper only to deal with the phenomena resulting from the application of small currents, for experiments with large currents are not easy, nor are willing subjects available, not to mention legal and other objections. It is, however, permissible to conclude that in proportion to the power of the current will the effect described be liable to exaggeration.

A.—With continuous currents we observe:—

1. Electrolysis at the parts in contact, accompanied by a gradually increasing sensation of heat, with the additional sensation of cutting, if the edge of an electrode be grasped or touched. This slowly increases until, when the current be sufficiently large, the pain becomes unbearable. If the circuit be suddenly broken, heat sensation continues to increase for a short period (one or two seconds) then gradually diminishes.

2. Shock to the muscles in the neighbourhood is felt with sudden make or break. This effect usually persists for a considerable time. An unvarying continuous current does not produce contraction of muscle.

3. The parts become reddened, more so at the negative than the positive pole. This is probably due to two factors; (*a*) stimulation of arterial stream near both conductors; and (*b*) paralysis of vasomotor-nerves at the negative electrode.

B.—With intermittent and alternating currents:—

1. Repeated shock, with more or less tonic contraction of neighbouring muscles, which is practically persistent during the time of contact. Closure of circuit is marked by painful jerk, felt not so much in neighbouring muscles as in those some short distance away. Thus when the hands grasp conductors with an alternating current, the jerk is felt first in the forearm muscles, then in those in the upper arm, and the latter is accompanied by pain which is occasionally long persistent after the circuit is broken (one or more days).

2. Reddening of the parts. In the case of the interrupted or alternating currents, this phenomenon is much the same at positive and negative poles, and is due probably to the same factors as in the case of the continuous current.

Light and power circuits carry currents very many times stronger than any used or named in the above experiments; and we may fairly conclude that the result of contact therewith would be severe shock to the nervous system, and strong burning sensation at the points of contact with either form of current. With alternating current there would be muscular fixation, in addition, such muscular fixation rendering the subject quite unable to release himself, and subjecting him to the full effect of the whole current passing.

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* Read Wednesday, March 11th.

Where the conditions of contact (as set forth above) are such that the body receives a large portion of the current carried, the results are necessarily very serious to the subject, and may easily prove fatal, either from the violence of the initial shock, and consequent fright, or from the continual passage of sufficient electricity to produce death by direct electrical action upon vital parts.

With regard to the relative dangers of the two forms of current (alternating and continuous), what we have above stated clearly indicates that the dangers resulting from contact with the conductors of an alternating current circuit are far greater than those resulting from similar contact with a continuous current circuit, even if the E.M.F. of the latter be double that of the former. This part of our subject is dealt with more fully in the papers referred to.*

THE USES OF ELECTRICITY TO THE HUMAN BODY.

The health of the body seems to be intimately connected with, and perhaps to a large extent dependent upon, electricity, or the immediate results of electrical action both internal and external That electricity ordinarily exists in the air we breathe, has been shown by many well-known experimentalists from Lemonnier, in 1752, downwards, and we have it on the authority of Sprague, that the average electrical condition of the atmosphere has an important bearing upon the climatic qualities of any place, though he adds "as yet very little is known on the subject."

Again, ozone is a most important constituent in a healthy atmosphere, and it is probable that electrical action is one of the chief factors in its production. Physiologists have long taught us that electricity is generated in our bodies during each functional process of whatever nature. It has been shown to be present during the action of the heart by Dr. Augustus Waller in his beautiful experiments before the Medical School of St. Mary's Hospital, in October, 1888, and more recently at the International Medical Congress at Berlin.

We are ourselves engaged upon a long series of experiments, which, so far as they have gone, clearly indicate that small but measurable currents of electricity are being continuously generated in the body. We further find that these currents differ in potential according to the parts tested, and we have reason to believe that such difference of electric potential is produced at the centres of function—thus in muscle, brain, gland structures, lungs, and various parts of the digestive system, there is a separate continuous, though apparently irregular, generation of current. The extent to which this body electricity may be dependent for its generation upon the various physiologico-chemical actions taking place in the body, is a question for the future. Meanwhile we are content to believe that atmospheric electricity in the process of the transformation and re-transformation of oxygen into ozone and ozone into oxygen, and in other ways, passes through a cycle of transmutations, starting as atmospherical electricity and finishing as the body currents mentioned. We are thus brought face to face with the fact that electricity forms a most important factor in the processes and functions which together constitute life; but there is no evidence in favour, or reasonable probability of proof, of the vaunted and oft-advertised statement that "Electricity is life."

A confirmation of our conclusions is found in the experiments of Dr. B. W. Richardson upon the effect of administering frequently used oxygen to animals. He found that oxygen alone will not continuously support life—in presence of nitrogen, of course—unless it be frequently revivified by the passage of electricity through it. The same action of electricity and its revivifying power upon the atmosphere, is found after a thunderstorm, when, as is well known, ozone is largely present owing to the electric disturbance accompanying the storm.

The artificial electrical generation of ozone for restorative purposes may also be considered as one of the uses of electricity to the body. It is one, moreover, which may probably prove of considerable importance in large cities, where the atmosphere is vitiated by the exhalations of a large and crowded population. We have made certain investigations into this subject, and carried out some interesting experiments with persons placed in an ozonised cabinet (invented and patented by Mr. Lawrence), wherein the air was charged with ozone by electrical action. The results seem promising; but the number and extent of the observations necessary, prevent the rapid completion of such research, and we must postpone more definite conclusions for the present.

The next part of our paper deals with the uses of electricity in disease. Such uses are numerous, valuable, and steadily on the increase. Without trespassing upon the distinctly medical aspect of the subject, we may refer to those well known, but little understood, effects of electricity upon the nerves and muscles of the body, by means of which many diseases depending upon nerve derangement may be ameliorated or even cured. Speaking generally, continuous currents, properly applied, tend to promote disintegration and nutrition, while alternating currents act as local stimulants. But in this connection it is most necessary to bear in mind that it is only by accurate measurement of the currents used, and by careful attention to the electro-physiological or electro-chemical changes it is desired to bring about, that satisfactory results can be obtained. Electricity is capable of doing much good to the body under numerous conditions, but that it is also capable of doing much harm we have already shown. Extreme care, therefore, is necessary in making electrical applications to the body. Care in diagnosis, so that a definite idea may be obtained as to what it is the electricity is to be directed against; care in the selection of that form of current best suited to do the work required to be done; care in choosing the position of the electrodes and the direction of the current; and, lastly, care in measuring the dose precisely, both as regards current, strength, and time. For an electrician who is not also a medical man to prescribe electricity is utterly wrong. For a medical man who is not also an electrician to administer electricity is equally wrong. For one who is ignorant of both electricity and medicine, to prescribe or adminster an agent so powerful for good and evil, is (or at least should be) criminal. The mysteriousness of electricity, and its subtle methods of action, render it peculiarly adapted to the purposes of the quack and the charlatan; while the indifference, suspicion, and conservatism of the medical profession, as a body, has hindered to an enormous extent the study and development of the uses of this valuable curative agent. The public have thus been thrown into the hands of men who, for the most part know absolutely nothing, either of electricity or of the diseases they profess to cure. Still, truth must prevail; and we are convinced that, however great the value of electricity in disease may be now, its possibilities in the near future are far greater.

With the methods of electrical treatment this paper has nothing to do, but there is one use of electricity in disease not indicated above, which is new as regards its practicability, and which, moreover, opens up a field of usefulness little expected a short time back. We refer to "cataphoric medication," or the process of passing drugs in solution through the skin by means of the cataphoric power of continuous electric currents.

Experiments have been made both in Germany and America, within the last few years, by which evidence, more or less uncertain, had been obtained of the power of electric currents to carry drugs in solution with them through the skin; but as far as our information goes, nothing reliable had been arrived at, and some of the experimenters were even uncertain as to which pole should carry the solution to the body.

In the early autumn of 1889 we conducted a series of experiments in this department of work, and found the results so promising, that we at once proceeded to use it as a method of treatment. We have been much gratified with the results of its application in many cases of actual disease. From the reports of the International Medical Congress at Berlin in 1890, we find that subsequent to our adoption of this method in practice, Mr. Edison, of New York, has been making experiments in the same direction.

We will here illustrate the methods by some experiments: Taking the facts in order, and certain conditions being observed:—

[*Experiments were here shown.*]

1. We note that a continuous current, passing from one vessel to another along a moistened conductor, will carry with it from + to − sufficient of the drug in solution at the + to produce a precipitate in the solution at the − pole.

2. That a portion of the drug in solution will pass through a porous septum in the direction of current flow.

3. That a portion of a drug in solution will pass into the human body through the skin also in the direction of the current flow, the skin here representing the porous septum.

(To be continued.)

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* This paralysis of circular muscular fibre is an important factor, for it is one of those made use of in such electro-surgical operations as dilatation of stricture, electrolysis of hair, &c.

NEW PATENTS—1891.

19,942A. "Improvements in the electro-chemical formation of chlorine and chlorine compounds." W. P. THOMPSON. (Communicated by F. Marx, Germany.) Dated March 5th. (*Complete.*) [This application, having been originally included in No. 19,942, dated December 6th, 1890, takes, under Patents Rule 23, that date.]

3,694. "Improvements in electrical switches." F. W. WEBB and A. M. THOMPSON. Dated March 2nd.

3,738. "Improvements in and apparatus for electrolysing and bleaching." J. MARX. Dated March 2nd.

3,740. "Improvements in electric meters." M. KOECHLIN. Dated March 2nd. (*Complete.*)

3,748. "Improvements in the production of slabs and blocks for electrical insulators and other purposes, and apparatus to be used in the manufacture thereof." A. MCLEAN. Dated March 2nd.

3,765. "Improvements in and connected with electric arc lamps." L. H. BUCHANAN. Dated March 3rd. (*Complete.*)

3,789. "Improvements in the depolarisation of electric batteries." B. J. B. MILLS. (Communicated by A. Bellemain, France.) Dated March 3rd.

3,799. "A new or improved solution or composition for charging electric batteries." A. CLARK. Dated March 3rd.

3,828. "Improvements in electric signalling and lighting for the prevention of railway accidents, and for lighting railway and other carriages." S. LEVY. Dated March 3rd.

3,867. "Improvements in electricity meters." R. KENNEDY. Dated March 4th. (*Complete.*)

3,868. "Improvements in arrangements and apparatus for electrically communicating with engine drivers of railway trains and others, for signalling purposes and otherwise." F. T. HOLLINS. Dated March 4th.

3,893. "Improvements in electrical cables." W. T. GLOVER and G. E. PREECE. Dated March 4th.

3,895. "Improvements in apparatus for transferring electric car batteries." F. G. CORNING Dated March 4th. *Complete.* [Date applied for under Patents Act, 1883, Sec. 103, August 5th, 1890, being date of application in United States.]

3,904. "Electrical switches." T. P. RICHARDS. Dated March 4th.

3,946. "A non-inflammable composition which is also a non conductor of electricity, and methods of producing the same." F. B. Pemberton. Dated March 5th.

3,957. "Improvements in instruments for measuring electricity." L. B. Miller and M. W. Woods. Dated March 5th.

3,967. "Improvements in portable electric safety lamps." T. Coad. Dated March 5th.

3,984. "Improvements in and relating to electric arc lamps." O. Patin. Dated March 5th.

4,005. "Improvements in dynamo-electric machines." F. Bryan. Dated March 6th.

4,044. "Improvements in electrical storage batteries or accumulators." R. H. Simpson. Dated March 6th.

4,064. "Improvements in electricity meters." G. Hookham. Dated March 6th.

4,099. "Improvements in electric arc lamps." W. H. Akester. Dated March 7th.

4,120. "An improved imitation candle for use with electric incandescent lamps." W. J. Fryer. Dated March 7th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

3,169. "Improvements in electro-heating apparatus." C. E. Carpenter. Dated August 6th, 1889. (Under International Convention.) 8d. The object of this invention is to utilise, economically, the heating effects produced by passing a current of electricity through a conductor of high resistance and small capacity, for the purpose of heating stoves, laundry machinery, flat irons, and similar utensils by producing heat in, and confining it to such part or parts only of the utensil as is desirable. 6 claims.

6,041. "Improvements relating to the transformation and utilisation of electrical energy." M. W. Dewey. Dated 22nd April. 8d. Consists, broadly, in charging a member of a condenser with electricity, and simultaneously therewith and thereby inducing a transformed charge of electricity on another member of a condenser, and then discharging the transformed charge through suitable electric translating or consumption devices. 16 claims.

7,994. "Method of welding metals electrically." C. L. Coffin. Dated December 12th. (Under International Convention.) 8d. Claims:—1. The described method of welding metals electrically, consisting in bringing the edges to be welded to a welding heat by the action of an electric current, and pressing them together by the attractive force of a magnet. 2. The described method of welding metals electrically, consisting in bring the edges to be welded to a welding heat by the action of an electric current, pressing them together by the attractive force of a magnet, and putting the weld under strain while subject to the action of the welding current.

9,780. "Improvements in electric railway signals." W. J. Smith and J. W. Fox. Dated June 24th. 8d. The object of the invention is to provide an improved, cheap, simple and effective arrangement, whereby the engineer of an approaching train on the main track will be notified if a switch is open and swung to throw his train from the main track, and also whereby the engineer of an approaching train will be notified of danger if a bridge or trestle work is in dangerous condition. 10 claims.

9,857. "Improvements relating to welding, soldering, brazing, and otherwise working metals by electricity, and to apparatus therefor." M. W. Dewey. Dated June 25th. 8d. Consists, essentially, in exposing or subjecting the part or parts to be operated upon to the heat of a continuous electrically-heated conductor in proximity thereto, thereby heating the said part or parts to the required welding, working, or treating temperature. Further consists in enveloping the part or parts to be heated and operated upon by the heating conductor, also in preventing radiation of heat from the said heating conductor in directions not toward said part or parts, and consists still further in conducting the heat from the said conductor to the said part or parts, through a non-electric conducting or high-resistance electric conducting medium. 21 claims.

10,134. "Improvements in covered or insulated electric cables or conductors and a compound therefor." J. Y. Johnson. (Communicated from abroad by J. H. Cheever, of New York.) Dated July 1st. 4d. Claims:—1. As a covering for electric conductors or cables the described compound of rubber, plumbago, asbestos, and sulphur combined in the proportions, or in substantially the proportions, hereinbefore set forth. 2. An electric cable having a continuous seamless covering composed of rubber, plumbago, asbestos, and sulphur, substantially as described.

10,595. "Improvements in apparatus for measuring electrical energy." Elihu Thomson. Dated 8th July. 1s. 3d. The inventor employs, in carrying his invention into practice, a coil which responds to the amount of current flowing through the consumption devices, and he employs an armature of considerable resistance which is in circuit between the terminals of the supply mains, or in a separate circuit of constant current, and therefore responds to the potential of the mains, such movable armature being directly affected by the magnetic field set up by the current in the said coil, which is in circuit, and conveys current to the consumption devices. He also employs a magnetic damper or retarder of the speed of motion of the armature, which magnetic damper acts by the development in it of Foucault currents or induction currents in a magnetic field.

11,025. "Improvements in connection with dynamo-electric generators for regulating the circuit currents to arc lamps." J. Y. Johnson. (Communicated from abroad by Higham Patent Right Company, of America.) Dated 15th July. 8d. Relates to the regulation of arc light dynamos, and its object is to so provide for the regulation that this class of dynamos can be made much cheaper and at the same time more efficient than has been heretofore permissible. 2 claims.

11,466. "Improvements in and connected with electro-magnetic friction clutches." T. M. Foote. Dated 22nd July. 11d. Consists in establishing an adhesive union between a moving part, which is permanently connected to and moves with the motor shaft, and a part which is connected with the work and moves the same, but is loose upon the motor shaft, this union being established by electromagnetism. 10 claims.

11,657. "Improvements in electric dental pluggers." W. E. Gibbs. Dated July 25th. 8d. Relates particularly to that class of mallet or plugger in which electric energy is employed for giving the blows. The object of the invention is to provide such an instrument similar to those known in the art except as to certain practical commercial advantages in detail which render the device free from difficulties met with in other forms of pluggers. 4 claims.

11,863. "Improvements in electric switches." W. W. Strode and C. G. Gill. Dated 29th July. 6d. Has for its object greater simplicity and durability than heretofore. 2 claims.

12,171. "Improvements in electric motor mechanism." S. E. Mower. Dated 5th August. 8d. Has for its object to construct a motor mechanism so that the armature of the motor may be mounted directly upon an axle or shaft, and the latter rotated at a substantially slow speed, while the said armature is revolving at a substantially high speed. 3 claims.

12,228. "Improvements in commutators for dynamo electric machines." J. W. Easton. Dated August 5th. 6d. The object of the invention is to prevent the uneven wearing away of the commutator sections and to afford an even bearing for the extremities of the brushes until the commutator is entirely worn out. 5 claims.

12,231. "Commutators for electrical machines." W. W. Vail. Dated August 5th. 6d. Relates to commutators, or devices for shifting the electric current from a continuous to an alternating current, and consists in an improved construction for such devices. 2 claims.

12,532. "Improvements in electric arc lighting." Sydney Pitt. (A communication from abroad by Messrs. Sautter Harlé & Co., of Paris.) Dated August 11th. 8d. The invention is an arrangement which results in the automatic replacing of the luminous facet of one of the electrodes to the position which has been assigned to it when for any reason it has left it. The position of the other electrode is regulated by the variation of the intensity of the current or counter electromotive force of the voltaic arc, so as to maintain a constant separation of the carbons during work. The sudden separation of the electrodes at the moment of lighting is brought about by the application of an electro-motor mechanism to one or other of the carbons. 5 claims.

12,634. "Improvements in dynamo-electric machines or electric motors." T. M. Foote. Dated August 12th. 8d. Claims:—1. A cylindrical field magnet composed of two semi-cylindrical sections, arc-shaped pole pieces within said cylinder at opposite sides thereof, and covering the joints between the semi-cylindrical sections, and bolts passing through the adjacent ends of said sections into said pole-pieces, substantially as described. 2. The combination of a cylindrical field magnet, a cylindrical armature therein, and a field magnet within said armature, having its pole-pieces adjustable relatively to the outer field magnet, a semi-cylindrical support for said field magnet, and bolts passing through said support near its upper edges and entering said cylindrical field magnet adjacent to the joints between the sections, substantially as set forth.

13,485. "Improvements in fittings for electrical glow lamp conductors." W. White. Dated August 27th. 6d. Claims:—1. The wall connection, substantially as described. 2. The ceiling connection, substantially as described. 3. The lamp socket connection, substantially as described.

12,777. "Improved safety connections or couplings for electric conductors." R. H. Gould and T. G. Schalk. Dated August 14th. 6d. Relates to improvements in safety attachments for couplings for electric conductors, and especially to the kind of device as described in specification No. 10,076, dated 30th June, 1890. 3 claims.

THE CONTACT DIFFERENCE OF POTENTIAL OF METALS: A NEW SUGGESTION.

Considering the war of words which, ever since Faraday's experiments, has raged over the theories which explain the disengagement of electricity by chemical means as of purely chemical origin, every new piece of experimental work which bears directly or indirectly upon it ought to be eagerly read; such work can hardly do otherwise than tend to support the now more generally received contact theory.

Amongst German physicists F. Paschen has recently made a great deal of research into the difference of potential of metals. Quite recently he has shown that an amalgam prepared by the electrolytic deposition of zinc on mercury exhibits certain electromotive properties which change after the amalgam has merely been allowed to stand for some time. To bring it back to its original condition or rather to restore its original properties it must be again submitted to electrolysis and for a longer time.

Here are some of Paschen's figures which illustrate this: 705·8 grammes of mercury were placed in a solution of sulphate of zinc of specific gravity 1·288; the current from two ordinary Daniell cells was allowed to pass for 30 seconds and this deposited zinc upon the mercury.

The amalgam of zinc and mercury produced in this way contains for every hundred grammes of mercury, 0·0000656 grammes of zinc. Paschen found that the electromotive force of freshly prepared amalgam / zinc sulphate / amalgamated zinc, was 0·14 volts.

After remaining for three hours the value of the electromotive force had risen to 1·1291 volts and in order to restore it to its original value a further electrolysis for 26 seconds was found necessary.

This interesting change, however, is only exhibited by an amalgam which contains a very small percentage of zinc; if this percentage be increased sufficiently the property of the amalgam practically becomes constant.

Paschen suggests that dropping electrodes, similar to those described by him in the *Annalen der Physik und Chemie* (series 2, vol. xli., p. 62) a short time ago might be used in determining the contact difference of potential of metals. The electrodes should be filled with the molten metals and these should then be allowed to flow into some suitable liquid electrolyte.

If, as in the case of mercury, there is no difference of potential at the place where the metal enters the electrolyte, the difference of potential between two such electrodes will be that of the metals which they contain.

It is obvious that, although the suggestion is very reasonable, great practical difficulties lie in the way of such experiments. In some cases, however, it appears possible to use in place of the molten metals themselves, the amalgams which they form with mercury, and examples of this were described by Paschen.

The original paper in which these results were described and the suggestion made may be consulted in the *Annalen der Physik und Chemie*, series 2, vol. xli., p. 186.

CORRESPONDENCE.

Cantor Lecture.

In your last issue Mr. King takes exception to the figures in my letter relating to the life of E.P.S. secondary batteries on tramcars, published in your number of the 6th inst. He says that the life of the positive plates is about 400 discharges, more or less, according to the degree of care in handling, giving at the same time the life of the negative plates as about 750 discharges.

Well, let us see how these imaginary life figures compare with the actual results obtained up to the present time with the service of cars on the Barking Road, that is, how they compare with the real life figures to which he takes exception.

The service of electric tramcars commenced (under Board of Trade rules and police regulations) on the 14th of June, 1889, the first complete renewals were ordered of the Electric Construction Corporation, Limited, by letter from the writer, dated January 16th, 1890, and delivery of same was completed at Barking Road, on the 14th of March following. They were at once put into service in lieu of the original batteries, now worn out by ten months' work. These second batteries continued in use until December last; they in their turn being then worn out with ten months' work. This time, instead of putting in complete renewals, an effort was made to economise by replacing the positive plates only, perhaps at the suggestion of the authority who, on inspection, had found that the first batch of discarded negative plates would certainly have run for another year. The result of these partial renewals has been that last month, the negatives which it was attempted to retain have had to be thrown out and new plates put in; these third batteries are now in use. Moreover, in order to keep the cars on the road during the time the old negatives were retained, a supplementary charge every afternoon from the dynamo was necessary, which meant extra fuel burnt, overtime made, &c., and three battery charges used in lieu of two per car and per day.

The life of the batteries is then, as shown in my letter (see ELECTRICAL REVIEW, 6th inst.), ten months, or 300 discharges, as well for the negatives as for the positives, and this with good, fair handling. With the actual handling and working of accumulators the writer has, perhaps, had more experience than your correspondent, and has been engaged on accumulators in Paris before their introduction into England.

No experiments, crucial or otherwise, have been made with the K type plates on accumulator cars in service.

The maintenance of traction batteries up to date is then 2¾d. per car mile; the one penny, like the two-thirds of a penny, being purely imaginary and prospective.

T. Frazer.

March 18th, 1891.

A Difficulty.

I am much indebted to you for your kind explanation of my difficulty, but owing no doubt to natural density on my part, the matter is not yet clear. Slingo and Brooker (p. 13, *Electrical Engineering*) define P.D. thus: "This difference of potential is known as electromotive force . . . ." I must say also that I fail to see the analogy between the two rings and the F.M. Had the rings been discs the similarity would be greater. It seems to me that the current flows round the rings, because the different parts of them are insulated from each other by air. If a number of rings, decreasing in size, *and all in contact* were used, would separate currents be generated in each one?

Potential.

March 17th, 1891.

["Potential" does not seem to at all grasp the situation; the distribution of currents, of course, depends on the shape of the moving field and the resistance of the various parts of the surface. But since any elementary area of the surface has a varying number of lines passing through it, a current must flow in it, and if we sum up all these currents we get a set of current rings as in S. P. Thompson. Our correspondent is trying to think of currents flowing separately, whereas we have a current sheet; he also seems still unable to distinguish between E.M.F. and P.D., therefore we commend him to read Fleeming Jenkin.—EDS. ELEC. REV.]

"Open v. Closed Magnetic Circuit Transformers."

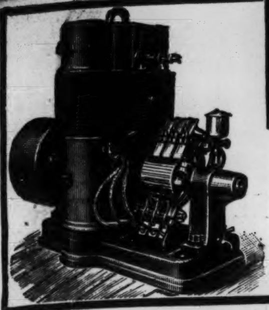
I have been carefully following Mr. Swinburne's paper and the discussion on the above subject, but up to the present have failed to understand how the open magnetic circuit transformer can have the high "all-day" efficiency that is claimed for it.

The open circuit transformer is allowed to take a larger exciting current than is required by the closed type (in one instance given by Mr. Swinburne it is half as much again), and the iron losses are evidently less. But Mr. Swinburne argues that the sum of the losses in the copper and iron is less than in the closed type.

Now how is the energy which is dissipated through these losses supplied to the transformer? Can it be supplied in any other way than from the supply mains in the shape of current, and is not the current which is called the exciting current (when multiplied by its actual E.M.F.) a measure of the total power being applied to and absorbed by the transformer? If it is not, than where does the power come from—this is wasted in the iron cores?

The conclusion has been forcing itself upon me that Mr. Swinburne has made out such a bad case for the closed magnetic circuit transformer because he has calculated the losses in the iron from Ewing's values and *added* them to the apparent losses in the copper coils (as measured). Instead of this, does not the apparent loss in the copper *include* both the actual copper and iron losses? And therefore is not the transformer which (all other things being the same) requires the least exciting current the most efficient?

J. H. R.



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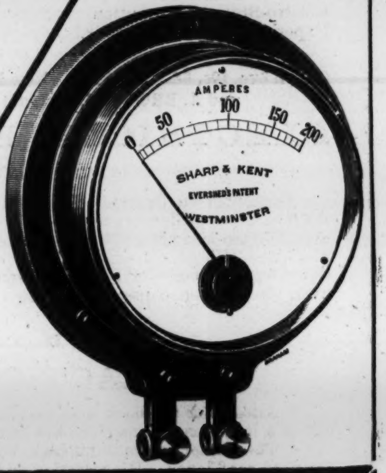

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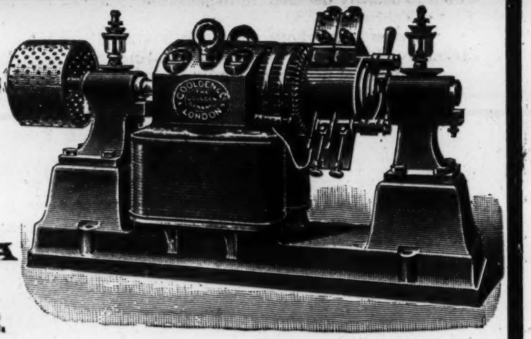

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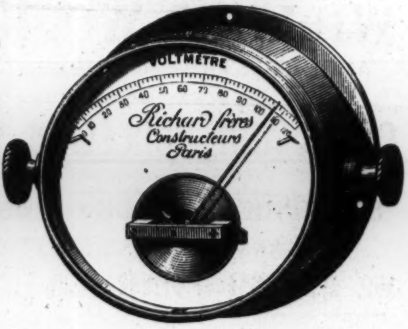

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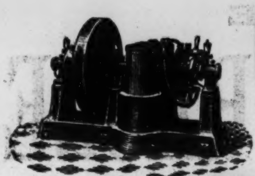

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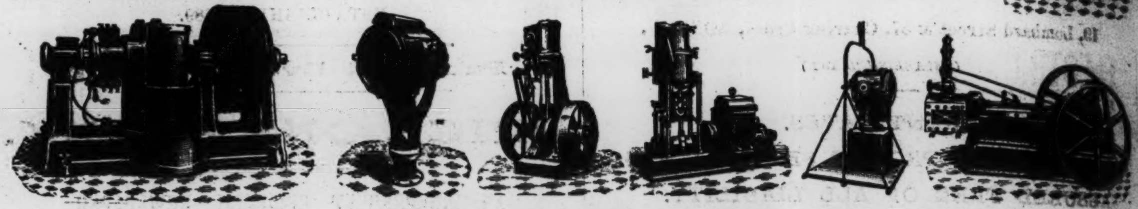

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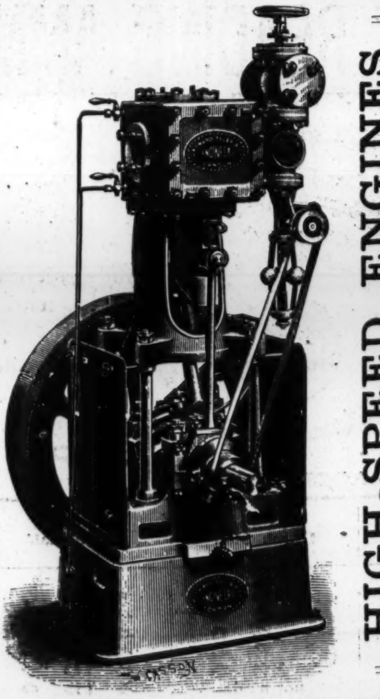

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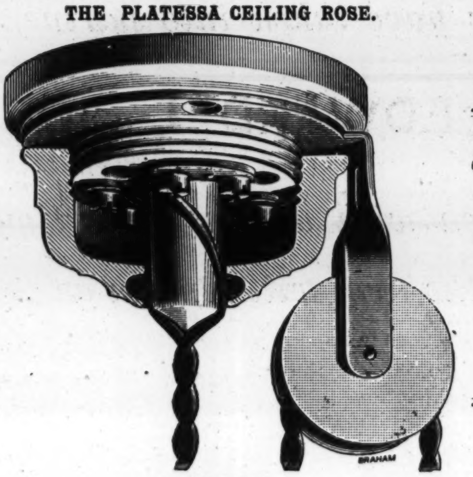

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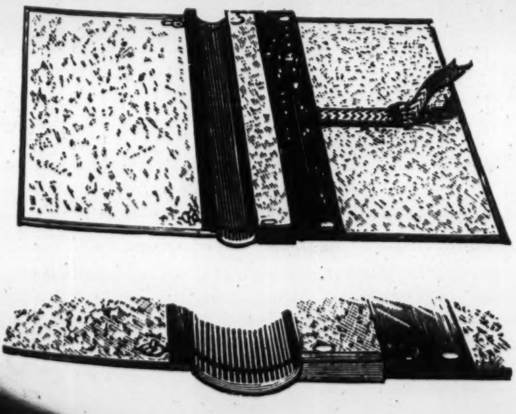

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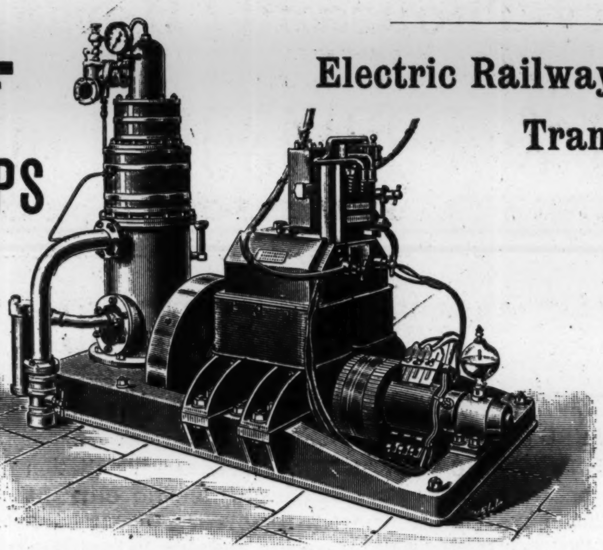

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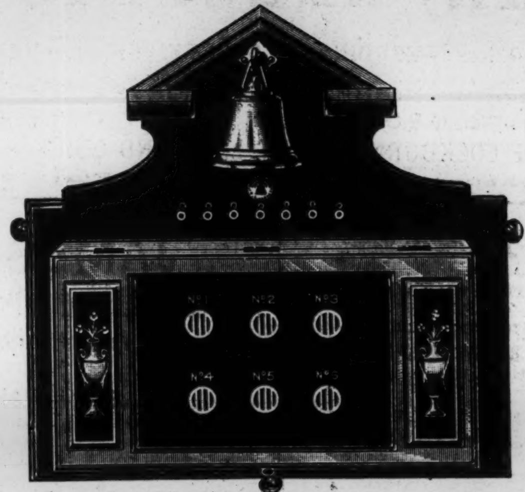

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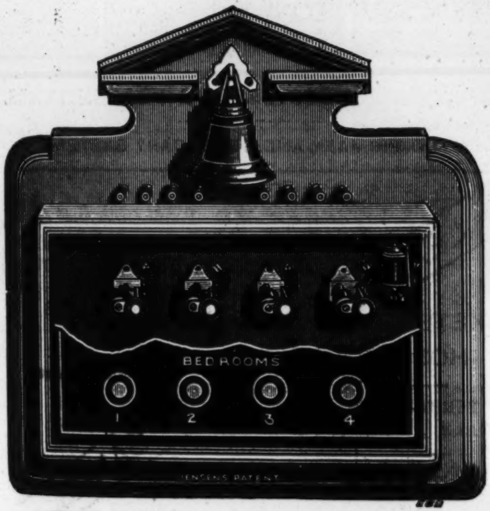

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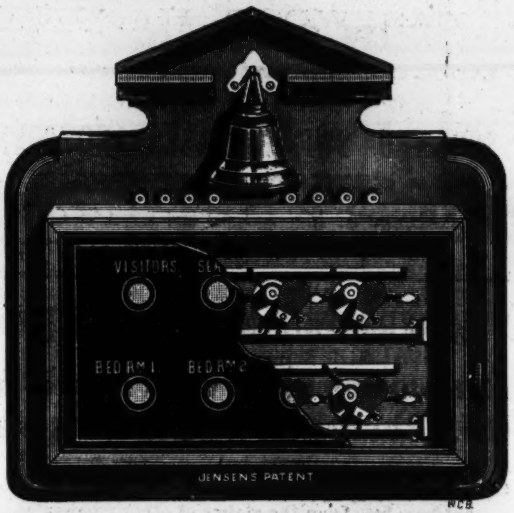

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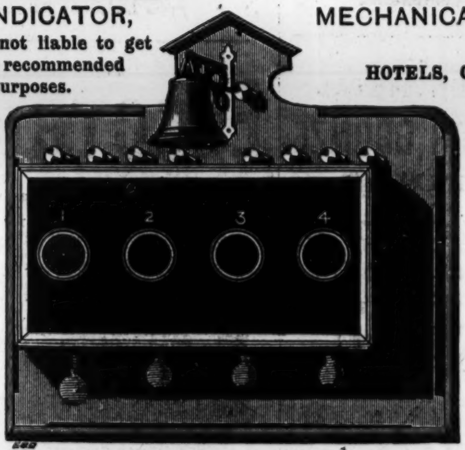

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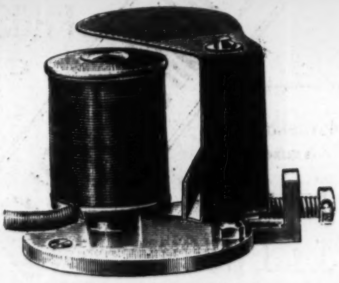

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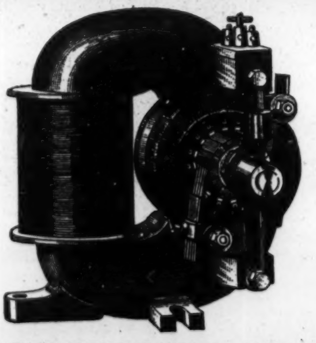

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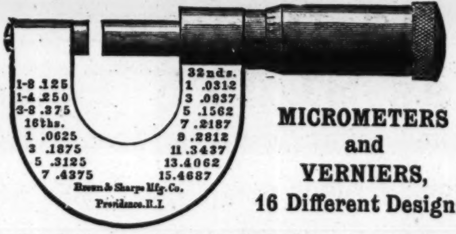

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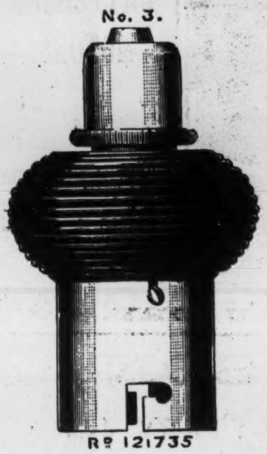

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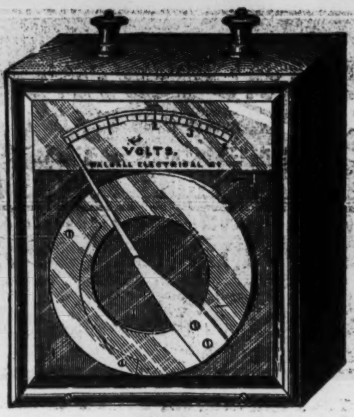

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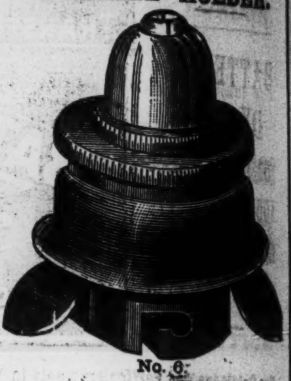

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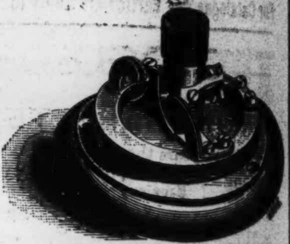

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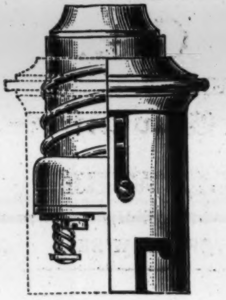

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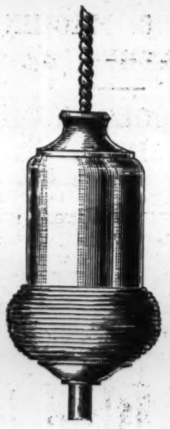

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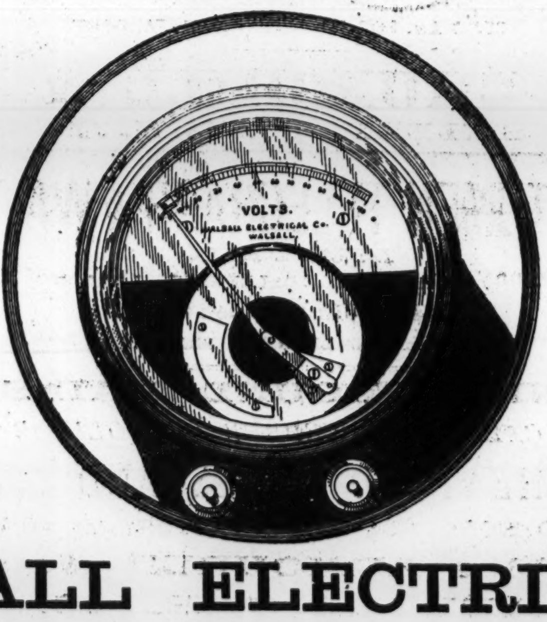

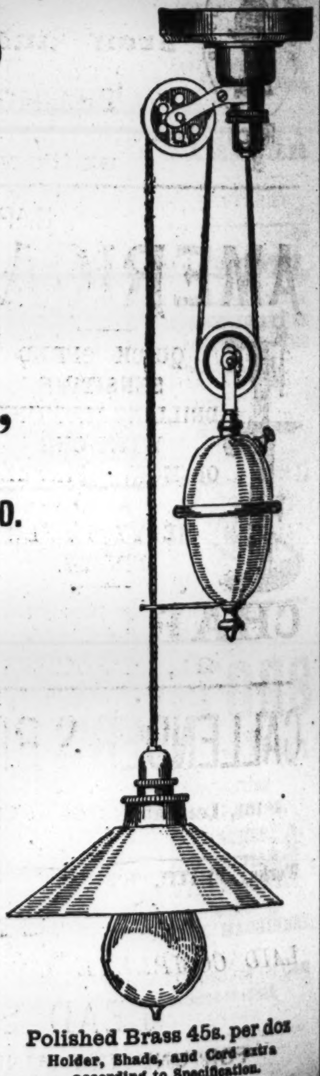

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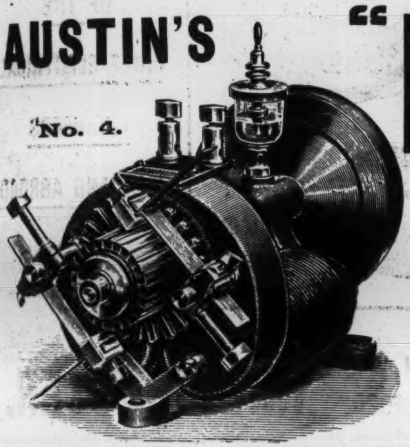

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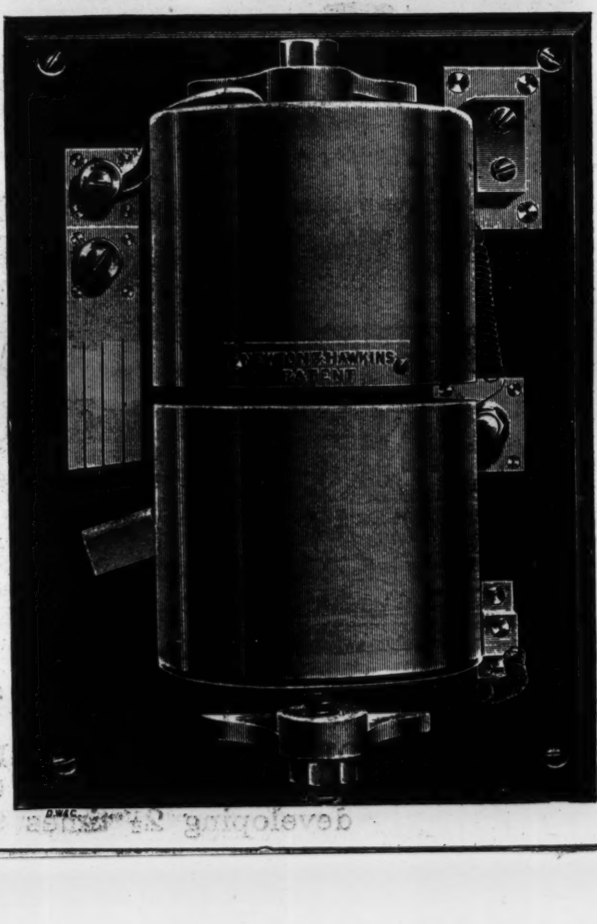

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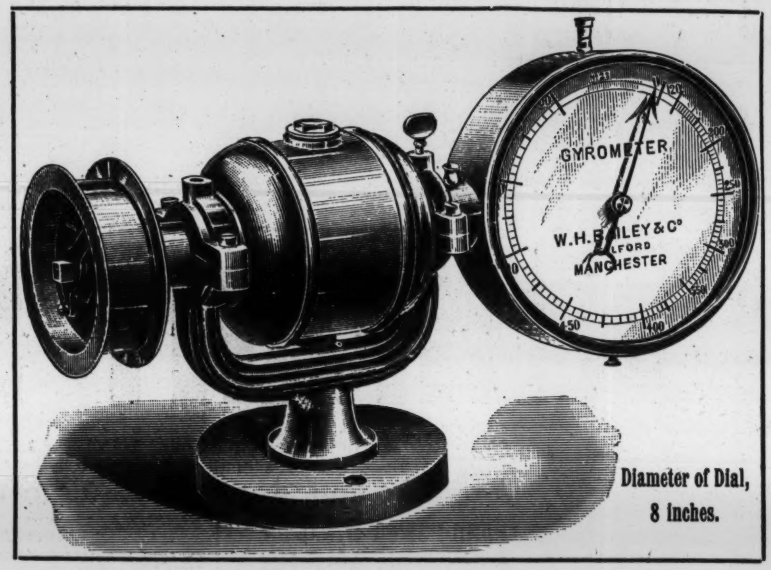

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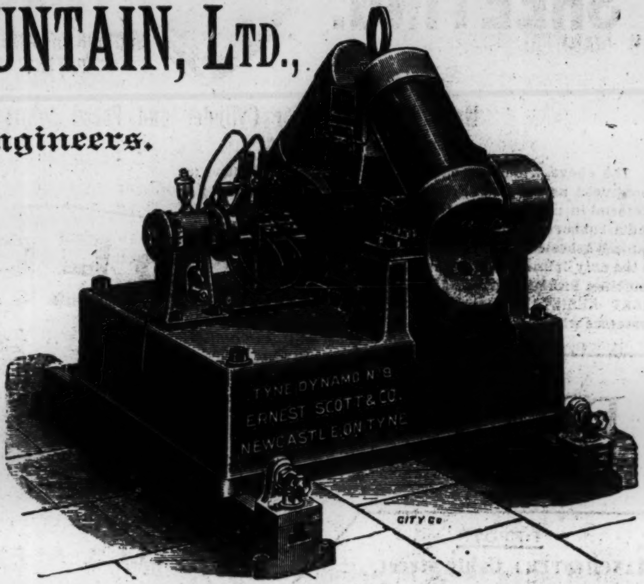

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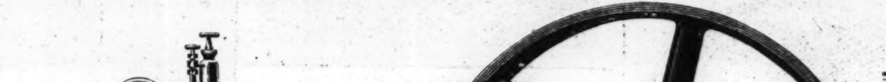

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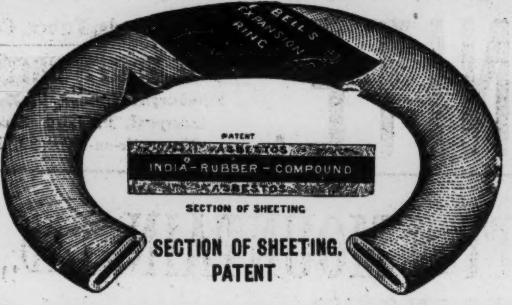

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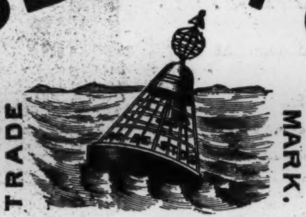

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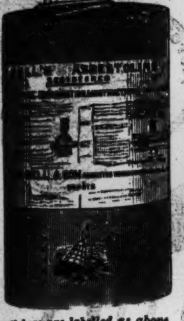

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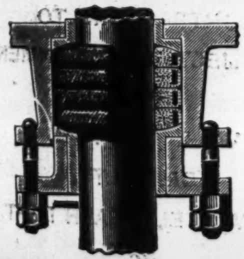

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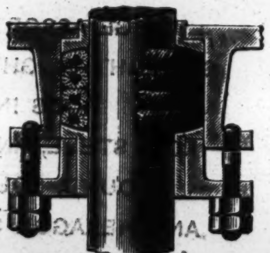

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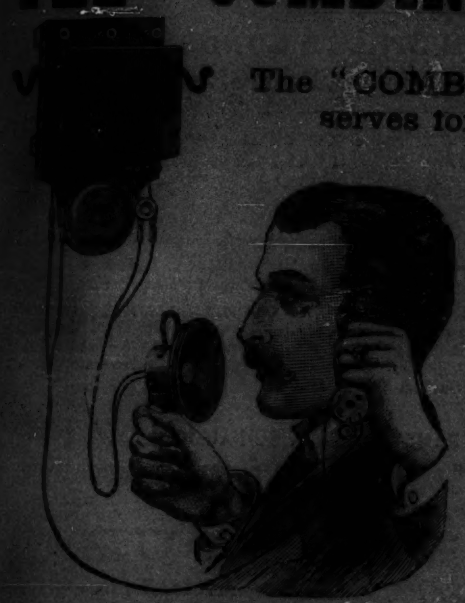

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